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An analysis of travel behavior of university population consisting of students, faculty and staff at Iowa State University

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An analysis of travel behavior of university population consisting of students, faculty and staff at Iowa State University

by

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CHAPTER 1: INTRODUCTION

The private automobile's dominance among travel modes used for the commute in USA represents a longstanding pattern. Driving is an important part of the United States economy and a major influence on American culture. In 2006, the U.S. had the highest car ownership rate in the world (IRF, 2007; OECD, 2003-2007). In 2000, personal automobiles were used for 91.2% of all personal travel while public transit (2.1%), walking (0.3%), and biking (0.1%) played minimal roles with respect to personal travel (OHPI 2000). The rate of public transportation usage among the foreign-born population was 10.8 %, more than twice that of the native-born population, at 4.1 % in the same year (ACS, 2009). Workers who lived in a principal city and worked in the metro area of residence had the highest public transportation usage rate, at 10.9 %. Smaller cities like Ithaca, NY, and Ames, IA, had public transportation usage rates of 6.9% and 6.1 %, respectively. The percentage of workers who usually travel to work using public transportation has remained at about 6.9 million (5 %) since the 1990 Census, but public transportation represents the second most common means of transportation after the private automobile (U.S. Census Bureau, 2010). Due to federal requirements concerning air quality, increasing congestion, lack of parking space, pressures to reduce traffic's impact on surrounding neighborhoods, and constraints on financial resources, many universities are exploring a range of environmentally sustainable solutions (Poinsatte & Toor, 2001).

What Are the Major Concerns in Travel Behavior?

Automobile use is linked to unsustainable trends such as climate change, oil dependence, traffic fatalities and injuries, congestion, oil dependence, urban sprawl, loss of

open space and obesity, auditory pollution, and the depletion of natural resources (Pucher & Lefèvre, 1996; TRB, 2001; Vuchic, 1999; Kolbensvedt, 1996). It was reported that personal automobiles emit about 10% of global CO2 emissions and the U.S. contributes about 45% of the world's automotive CO2 emissions (DeCicco & Fung, 2006). Despite the fact that technical improvements have decreased the pollution per vehicle, the environmental gains have been lost through the more extensive use of private cars (National Kommitten for Agenda 21, 1997). Over 30% of all CO2 emissions in the U.S. are caused by the transportation sector (BMVBS, 1991-2008; ORNL, 2008). Lastly, American households spend roughly 19% of their disposable income on transportation.

Sprawl development has been prevailing in the U.S. during the past several decades (Kolankiewicz & Beck, 2001; Fulton, 2001) and it has been criticized for its contribution to auto dependence. Low density, segregated use, and poor accessibility increase trip lengths and make transit and non-motorized modes unattractive; most people living in sprawling areas have to rely on cars to conduct their daily activities. Ewing et al. (2002) found that, on average, people in the 10 most sprawling metropolitan areas drove six miles per capita per day more than those in the 10 most compact metropolitan areas. Studies found that residents living in traditional neighborhoods (characterized as high density, high accessibility, mixed land use, rectangular street network, and so on) own fewer vehicles, drive less, and walk more than those living in suburban neighborhoods (Cervero & Duncan, 2003; Crane & Crepeau, 1998; Friedman, 1994).

Factors Affecting Travel Behavior

Previous researches indicated land use and built environment, physical disabilities, the need to travel with children, lifestyle, socio-economic status, driving frequency and habit, whether the trip is chained to other trips, trip companion, time constraint, topography, weather, availability and quality of alternative modes and perceived exertion of the modes, parking constraints, and safety and expected effort required to use public transit or non-motorized alternatives are examples of important factors (Kim and Ulfarsson, 2004; Cervero 2002; Srinivasan & Ferreira 2002). A review of 50 international comparative studies show that differences and similarities in travel behavior within and across countries are mainly attributed to transport and land-use policies, demographic and socioeconomic factors, spatial development patterns, and cultural preferences (Buehler, 2008). Another stream of literature have categorized the determinants into 6 categories such as (1) Physical environment and urban form factors (population density, land use mixture, availability of infrastructure, and multimodal network's connectivity), (2) Mode-specific factors (availability, access, convenience, comfort, privacy, freedom, safety, travel time and cost, (3) Trip-makers' personal attributes (occupation, marriage status, gender, age, income, day-care responsibilities, car ownership and possession of a driver's license), (4) Trip characteristics (time of travel, trip purpose, trip distance, trip origin and destination), (5) Presence of Travel Demand Management (TDM) measures (parking cost or restriction against car usage and transit pass subsidy), and (6) Psychological factors (habit, attitude, concerns over health and the environment, familiarity with alternative modes to driving and unconscious attachment to car usage) (Web of Science, Engineering Village and TRID databases).

Need to Study the Travel Patterns of University Population

College campuses are privileged places to communicate sustainability and to help reshape society's transportation patterns due to their pro-active educational milieu (Carlos, 2003). In 2008, there were over 13 million full-time college students and nearly 6 million part-time college students in the United States (US Census Bureau, 2008), the largest portion of young adults (Shannon, 2006). College campuses are often some of the largest employers within communities in the US and their sustainability efforts would help establish exemplars for other employers and even for the society at large. Colleges and universities nationwide employ approximately 3.6 million faculty and staff (Carlos, 2003). Thus promoting and studying sustainability in general and encouraging sustainable travel behaviors at universities in particular are not a trivial issue.

College campuses are very distinct communities. They are the places where people of different backgrounds, incomes, lifestyles and attitudes do come together to live, study, work, and recreate (Ojeda & Yudell, 1997). Within American cities, university campuses can be expected to be among the more likely places for non-motorized travel to occur (Whalen, 2013). University population are less likely to own cars, yet college campuses often remain automobile focused (Delmelle, 2012). Universities also impact neighboring communities in many ways, such as parking, traffic, service access and off-campus housing. Though journey-to-work has been subjected to investigation for decades, there has been limited research on travel behavior of university population (Kerr, Lennon 2010).

In Context with the University in a Small-City Setting

Transportation plays a significant role in establishing not only a more sustainable campus, but also contributes to the overall sustainability of the city or the town of its location. This is especially true in small-city university settings where the campus serves as the major trip attractor for employees and students alike (Shannon, 2006). Balsas et. al (2003) has argued that university campuses represent a microcosm of society; and are hence an ideal setting for exploring policy initiatives for reducing automobile dependence. Ames is one of the premier towns of Iowa with about 2.04 % share of the state's population. The city has an area of 24.27 square miles, and according to the 2014 census has a population of 63,266 million (U.S. Census Bureau, 2014).

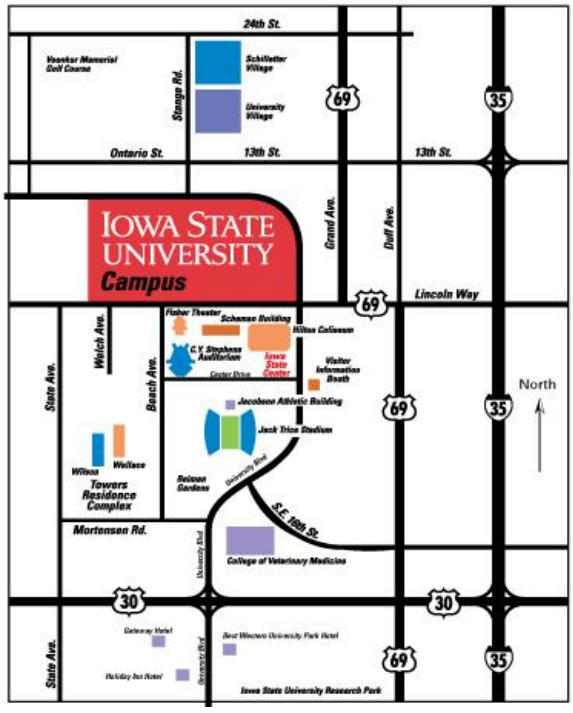


Figure 1: Location Map of Iowa State University

Iowa State University at a Glance

The Iowa State University is located in the city of Ames, Iowa and is the major employer of the town. In 2010, the University had 5,800 employees (Facts 2010-11, ISU) and 34,732 students were enrolled in 2014 (28,893 undergraduate, 4,950 graduate and 592 professional students) (Office of Registrar, 2014, ISU).

The university has a well-developed system for bicycle parking, including public bicycle racks, bicycle-storage facilities and individual bicycle storage lockers. ISU also has a pedestrian priority campus to support walking and pedestrian safety. Bicycle lanes run across the campus and have both off-street and on-street routes. Vehicle parking is available on campus for the employees, students, and visitors. Parking costs $158 and $137 respectively for employees and students for an academic year. Motorcycle charges are $53 a year. Number of annual parking permits sold is 15,344. Paid parking is also available on campus. Commuters can park at the designated parking lots at the Iowa State Center for free and take CyRide's Orange Route into campus. Including the residence parking off-campus, students have about 10 lots (Department of Public Safety, Parking Division, Iowa State University).

CyRide is the city bus system for Ames, Iowa. It is a collaboration between the City of Ames, Iowa State University (ISU), and ISU's Government of the Student Body (GSB) and receives funding from all the three (Figure 2). Additional revenue is generated from cash/ticket/pass sales and other smaller sources such as advertising revenue and interest income.

Figure 2 shows the breakdown of funding sources for CyRide service. Fuel prices and lower state revenues have resulted in budget crises around the nation. CyRide's ridership continues to increase providing more than 6.6 million rides in 2014. This will make service reductions challenging for CyRide and the community. This is why it is important to gain the community's input and try to address these issues to the greatest extent possible.

CyRide operates 12 fixed routes with 93 Buses (as of June 30, 2014), 4 Admin vehicles, 2 trucks, a Dial-A-Ride service for persons with a disability, and a late night service called Moonlight Express. The operating expenses in 2014 were $8,866,644. All ISU students pay mandatory student services fees per semester which includes $97.85 for CyRide unlimited services.

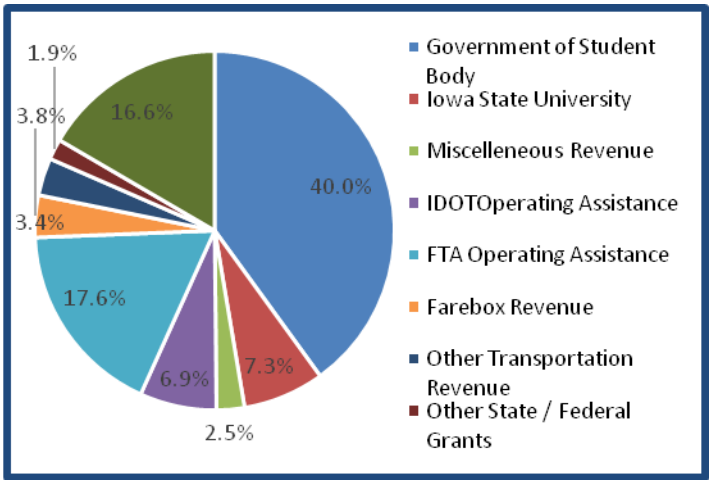


Figure 2: CyRide Revenue Sources FY2013

The ridership statistics show a steady and rapid increase since 1977 (Figure 4), almost 70 times in the last 36 years from 1977 to 2013. If we compare this increase with the student population enrolled to the university every year (Figure 3), we will see the population growth is not as pronounced as the increase in ridership. When the CyRide ridership grew about 70 times (i.e 7,000 %) over the last 36 years, the student enrolment increased by only 1.5 times (150 %) during the same time. This indicates that over time, more students are using CyRide service, choosing the same over driving.

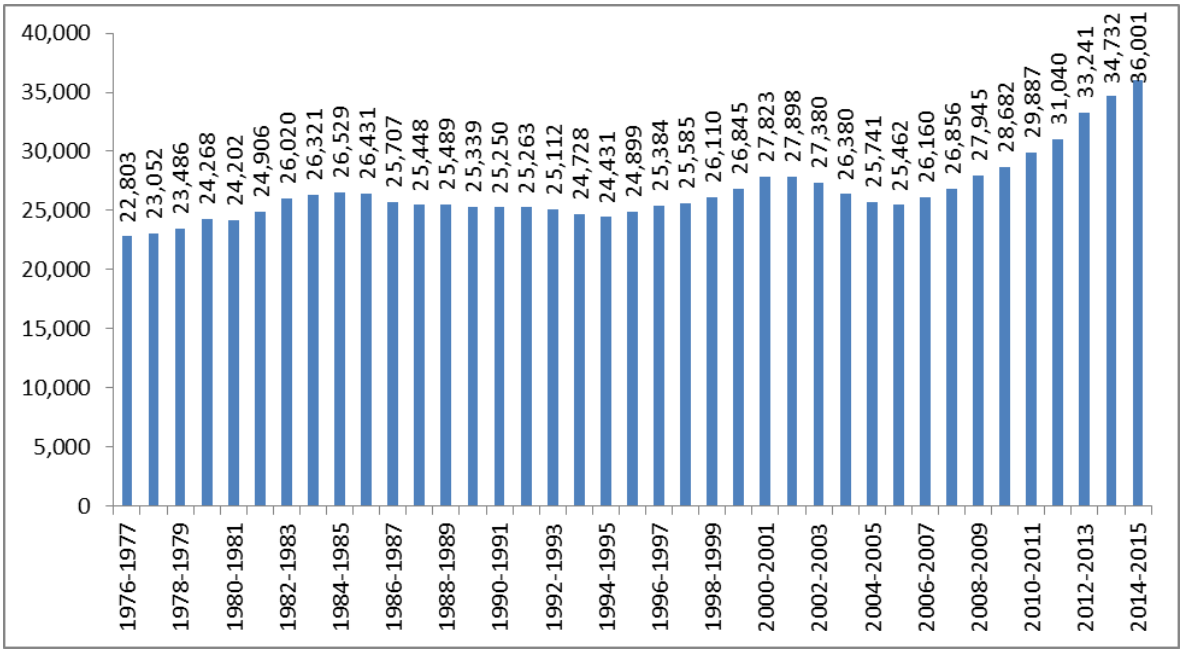


Figure 3: Growth of Student Population at Iowa State University from 1977 To 2015

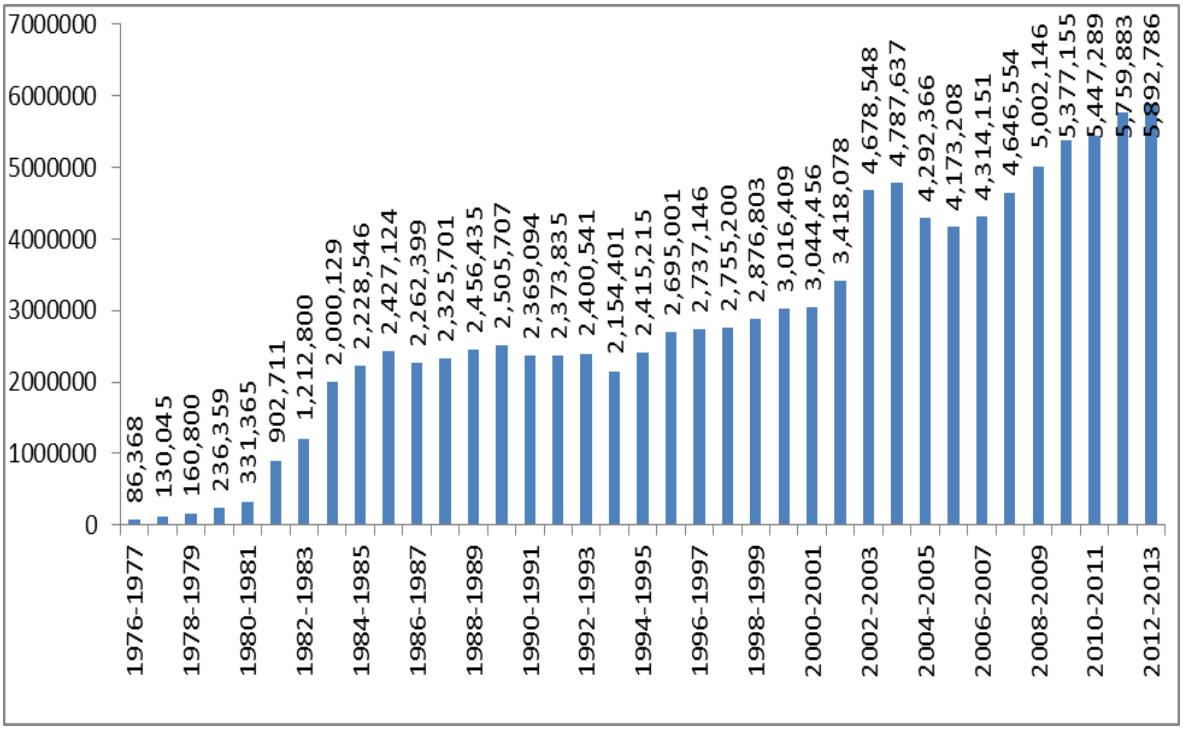


Figure 4: Ridership Growth of CyRide, Ames from 1977 To 2013

Research Objective and Questions

As previously mentioned, very little is known of the students and employees of university towns in the Midwestern states of US. To fill this research gap, the overall aim of the thesis was to study perceptions toward public transportation and important determinants and characteristics of travel behavior of university (in this case, ISU) population in a small-city for the trips made between campus and residence. As the travel behavior and the influencing factors for the students would vary vastly from that of the employees (faculty and staff), two similar yet parallel studies need to be carried out. Research questions that are addressed in this study are:

(1) What are the modal choices of the students and employees in a small-city university setting?
(2) How employees and university students from the same university are different in terms of travel behavior?
(3) What are the influencing factors or determinants of the travel pattern of the above mentioned population, and how do they affect?
(4) What are the current attitudes toward public transportation? Is there an observed willingness to switch from private cars to public transport?

CHAPTER 2: LITERATURE STUDY

Existing literature examining mode choices and their determinants among general population have been extensive. These have been categorized into different themes, relevant to this analysis.

Social-Economics

Social-economic factors have been commonly used by metropolitan planning organizations (MPOs) and academicians to forecast people's mode choice (Pinjari, 2011). Regarding income and work classification, Gordon et al. (1991) suggested that low-income and low-skilled workers should have shorter commuting distance. Cao et al (2009) also found that preferences/attitudes and the built environment play a more prominent role in explaining the variation in non- motorized travel than for auto and transit travel. In the UK, Maxwell (2001) showed that many students drive or are planning to do so once they have enough money because of affective motivation and the symbolic function of the driving. Analyses show that higher incomes, more cars per household driver, and employment are related to more car travel.

Land Use, Built Environment and Spatial Development Patterns

The findings of study concerning land use and built environment's impacts on travel by Ewing and Cervero (2010) suggest that: (a) as a whole, land use and built environment is not a significant predictor of mode choice. (b) Several aspects of land use and built environment, jointly, however, are a significant predictor of mode choice. Bus and train uses are equally related to service proximity and street network design variables,

with land use diversity a secondary factor. Studies found that people in low density areas tend to travel longer distances, own a car to a larger extent, and travel more by car (Dargay & Hanly, 2007; Giuliano & Dargay, 2006). Specific land use policies used in smart growth programs include transit-oriented development, pedestrian-oriented development, infill development, mixed-use zoning, Main Street programs, brownfield development, and so on. Studies by Handy, (1996a); Crane, (2000); and Ewing & Cervero, (2001)provide insightful evidence of the link between the built environment and travel behavior. A mixed-use zoning program helps to discourage car use and reduce vehicular trip distances, promote safe and active pedestrian environments, increase residential and employment density to support transit. The built environment characteristics are much more significant predictors of VMT, which is the outcome of the mode choice (Ewing & Cervero, 2001). Over the last 50 years the U.S. experienced increasing suburbanization and decreasing population densities (Buehler, 2008; Kenworthy & Laube, 2001; Stein, Wolf, & Hesse, 2005). Analysis shows that higher population density and a greater land use integration of workplaces and housing reduce car use (Khattak, 2011; Eom, 2009).

Role of Auto Ownership

Auto ownership has a strong influence on travel behavior, as countless studies show. According to the National Household Travel Survey (NHTS, 2001), households without a vehicle made 34.1% of their trips by auto, 19.1% by transit, and 43.5% by non-motorized modes; in contrast, households with one vehicle made 81.9% of their trips by automobile and households with 3 or more vehicles made 90.5% of their trips by automobile (Pucher & Renne, 2003). A study of cities in the U.S., Australia, Asia, and Europe found that the significant increase in vehicle travel between 1960 and 1990 was a

direct result of increased incomes and greater automobile ownership (Cameron, 2003). Auto ownership is a critical mediating link between the built environment and travel behavior; the built environment influences auto ownership, which in turn impacts travel behavior (Ben-Akiva & Atherton, 1977).

Institutions and Transport Policies

Travel mode choices are deeply influenced by the systems and related institutions, which include financing and pricing of alternative transportation. At the individual and employer levels, Zhou and Schweitzer (2011) have explored how particular institutions like transit fare and subsidies, information assistance for transit riders, university-owned housing, and employer-sponsored vanpool programs have influenced university employees' travel behaviors. Across different levels of detail, there have also been reports on how different institutions such as transit promotion, parking management and pricing and Travel Demand Management (TDM) measures affect travelers' responses and behaviors (Transportation Research Board, 2003, 2005, and 2010). Boyd et al. (2003), for instance, showed that a free transit pass program called "BruiGO!" increases the share of public transit among university students. Using eight universities as examples, Balsas (2003, p.35) have shown what universities have done to promote biking and walking and why universities are an ideal place to "communicate sustainability and to help reshape society's transportation patterns."

Personal Capabilities and Demographics

In studies of travel behavior, various socio-demographic factors have been examined. These consist of the individual's knowledge, available time and money, social

status, and power. Some of the demographic factors are age, gender, family status etc. For example, women tend to travel shorter distances and use the car less compared to men (Giuliano & Dargay, 2006 SIKA, 2007a; Steg, Geurs, & Ras, 2001). In addition, age is often negatively related to travel distance (Giuliano & Dargay, 2006; Hunecke, Haustein, Grischkat, & Böhler, 2007; Mokhtarian, 2001). Studies have generally found a positive relation between income and travel distance as well as between income and car use, indicating that individuals with higher income tend to travel more and use their car more compared to those with lower income (Dargay & Hanly, 2007; Giuliano & Dargay, 2006; Mokhtarian, 2001; Poortinga, Steg, & Vlek, 2004; Steg, 2001).

Social Context, Attitudinal and Psychological Factors

Psychology has come a long way in analyzing determinants of travel mode choice in recent years (e.g., Bamberg & Schmidt, 1998). It assumes that sustainable travel mode choice is a direct outcome of intentions to use sustainable modes of transport and perceived behavioral control (Hunecke et al., 2001). Attitudinal factors include environmental and non-environmental attitudes, beliefs, values, and personal norms, while habit represents the tendency to act without thoroughly considering the behavioral choice. Subjective norms represent the perceived social expectation of relevant other people for each behavioral alternative (Klöckner, Matthies, & Hunecke 2003) and influence travel mode choice. According to Guagnano, Stern, & Dietz (1995), attitudinal factors and behavior are strongly related only when contextual factors are neutral.

Studies Pertaining to Students and Employees

In recent years, some studies can be found that deal with different aspects of the travel patterns of university population. These include, among other topics, the use of GIS to visualize and assess travel behavior (Kamruzzaman, 2011), modal choices (Delmelle & Delmelle, 2012; Klockner & Friedrichsmeier, 2011; Zhou, 2012), and activity patterns (Chen, 2012; Eom, 2009; Eom 2010). Shannon et al. (2006) performed an online survey of commuting patterns and attitudes towards switching to active modes of an urban university population in Perth, Australia and investigated the issues which influenced their travel decisions. The students mentioned travel cost savings, and avoiding the hassle of finding parking as the chief motivating factors for using active transport, while infrequent public transport service was indicated as a barrier for using this mode. This suggested that potential policy measures include increased parking costs, improved bus and bicycling service, more student housing close to campus, and the implementation of a public bus pass to help shift transportation modes. From a US perspective, Toor & Havlick (2004) provide an overview of sustainable transportation case studies with regard to planning and policies. In terms of policies aimed at decreasing automobile dependence among student commuters, subsidized parking on university campuses has received attention in the literature as a catalyst for disproportional automobile use (Shoup, 1999). Transit-university partnerships are another policy initiative aimed at reducing student automobile dependency. These programs often feature unlimited transit access and have been common features of university transportation management plans since the late 1970s (Bond & Steiner, 2006; Brown, 2001). In a small, compact, university town setting where the university is the major employer, and where destinations can be reached within a relatively short distance,

automobile alternatives are a very plausible solution. Therefore, incentives identified by its residents to switch from a car to an alternative mode for in-town trips hold a promising potential for reducing automobile use.

Student travel is rarely investigated in national surveys, including National Household Travel Survey (NHTS), and only a few documented surveys focusing on the travel behavior of university students exist in the reviewed literature (FHWA, NTHS 2009). The study by Kerr et.al. (2010) focussed on the student's car commuting behavior of Queensland University of Technology (QUT) in Brisbane. They found that the students' use of cars could be predicted by their intention to drive. The group frequently travelling by car was more supportive of car travel than the group that was less reliant on cars. The students generally regarded using car for journey-to-campus trips as convenient, reliable, comfortable, secure and pleasant. A few other existing literature, as argued by Balsas (2003) and Zhou (2012), however, have studied alternative transportation among university students. Most authors have dealt with car dependence or dominance among the general population or employee, its causes, consequences and/or cures (Newman & Kenworthy, 1999; Mark, 2009; Scheiner, 2010; Barrand Prillwitz, 2012; Susilo et al., 2012).

According to the literature, university students, however, are different from the general population, particularly the employees (Boyd, 2003; Collins & Chambers, 2005; Bamberg, 2003; Klöckner & Friedrichsmeier, 2011; Rose, 2008; Gärling & Fujii, 2009). They have some control over their course schedule and time of commute and can often avoid two peak hours typically faced by most employees. Most university students are unmarried and/or have no kids and thus do not have any day-care responsibilities to constrain their transportation and housing choices. Compared to workers, university

students are lower in car ownership or access (Khattak, 2011; Santos, 2011). Due to facts such as lower (or even no) income and younger age, university students are more likely to use public transportation, bike or walk than the general population. University students overall have more positive attitude towards TDM measures than the general population (Toor & Havlick, 2004).

As whole, the above literature review indicates: (a) little has been done on university populations', especially the students' mode choice and its influencing factors, particularly in the US context and (b) few policy recommendations based on empirical results are in place about promoting sustainable mode choices among university students. This study tries to focus on the travel behavior of university population for the trips from residence to university, addressing the existing gap in the literature.

CHAPTER 3: RESEARCH METHODS

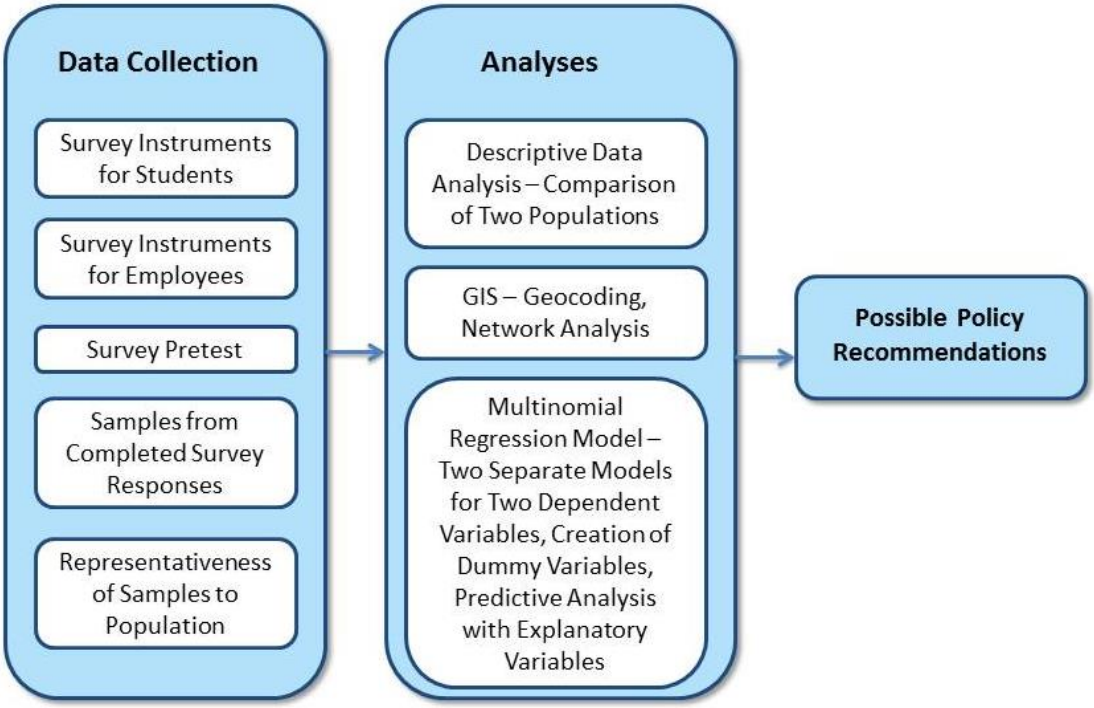


Figure 5: Research Methodology

Data Collection: Survey

This study was a cross-sectional examination of travel patterns and influences. Primary data were collected exclusively using an online electronic survey. A complete list of email addresses of the students was requested from the Office of Registrar and the same was shared with the IT department to send out the survey to all the regular students presently enrolled in the second week of Spring 2015. A similar list for all the email addresses was requested from the Office of University Human Resources and has been given to the IT department for conducting the survey in the third week of the semester. Prior to conducting the survey, IRB training and certification were required to be attained by the principal investigator. Two separate survey questionnaires were created on Qualtrics

by the investigator, keeping in mind the probable significant difference in the travel behavior of the students and the employees. The study was approved by the Institutional Review Board at Iowa State University (IRB Approval in Appendix A).

Survey Pre-Test

Two separate pre-tests were conducted before the questionnaires were finalized and sent out to everyone, one for the students and another for the employees. 12 students and 3 faculty members have been involved in these pilot tests. Various feedback and suggestions were received by the participant of the pre-tests, many of which have been incorporated in the survey questionnaires, wherever suitable.

Survey Design

Questions in the survey were formulated with the aim of understanding which modes of transportation are used by the students and employees and the reasons for their mode of choice, their overall feelings about the current infrastructure and commuting environment, and to gain some insight on specific initiatives that would encourage them to switch to non-motorized or public transportation from driving. The survey was divided into six sections. Section 1 consisted of 3 questions on participant's general travel behavior and primary mode of travel, Section 2 had 4 questions which asked the details of the trips from residence to campus. Section 3 questions the factors that influence the travel mode selection, while Section 4 tries to gauge the perceptions toward public transportation in general and especially on CyRide. Section 5 are on walking and biking and Section 6 asks for the individual information of the participants. Surveys typically took 10 to 15 minutes. to complete.

Survey Responses

In total, the responses from the students were 4.14 % (1,134 out of 27,361 excluding the non-regular students) and from the employees were about 15.59 % (1,021 out of 6,547). Out of those responses, completed surveys were 895 and 868 for students and employees respectively. These sets of completed responses were taken as samples from the two populations.

Representativeness of Samples from Populations

As there was no formal or conventional way to draw the samples from both the populations, a study on the representativeness of the samples from the population was done. Information on many of the variables of the population was not available. The independent variables, on which information of populations could be found, were compared with that of the samples as below in Table 1 and 2.

Table 1: Representativeness of Students Sample with Its Population

Variable	Sample of Students	Population of Students
Undergraduate Students %	71.17	84.63
Graduate Students %	28.83	14.50
International Students %	10.61	11.46
Female Students %	62.82	43.89
Male Students %	37.18	56.11
Students Average Age (years)	23.03	22.02
On - Campus Student %	47.30	35.29
Off Campus Student %	52.70	64.71
Race & Ethnicity of Students %		
White %	79.55	76.75
African American %	9.16	2.75
American Indian and Alaska Native %	0.45	0.25
Asian %	9.50	2.90
Native Hawaiian & Other Pacific Islander %	0.00	0.10
Other %	1.34	17.25

Table 2: Representativeness of Employees Sample with Its Population

Variable	Sample of Employees	Population of Employees
Female Employee %	60.59	50.70
Male Employee %	39.41	49.30
Employee Average Age (years)	48.31	34.43

As we see from above, proportions and averages of some of the variables from the samples match closely with that of the population. However, in some cases they differ drastically. Based on the above observation, we can say that there is a possibility of this study to be somewhat biased, as the samples do not accurately represent the respective populations.

Measures and Variables

Three different types of measures were used in this study: (1) measures that apply only to the trip, (2) measures that apply only to the person, and (3) the dependent variables. The independent variables considered here are individual socioeconomic, demographic, attitudinal. The dependent variable in this study is the travel pattern or behavior and willingness to change of travel behavior of the aforementioned populations. The questions asked in the surveys were based on the three below dimensions:

Individual-level demographic influences: Participants were asked to report their age, sex, current program (Bachelors, Masters or Doctoral for the students), nationality, race and ethnicity (for students). Individuals were also asked to respond to demographic items that could impact their choice of transportation to campus including: having access to a car, traveling to other locations before and after campus, income and economic constraints.

Psychological influences: Participants reported the reasons for choosing their travel mode and willingness to shift to public transportation, walking and biking.

Other influences: Individuals were also asked to respond to environment items that could impact their choice of transportation to campus including: availability of sidewalks, preferences of traveling companions, weather, safety from traffic or crime, and parking cost and availability. Participants were also asked to report the time it takes to go to the campus and time to walk to nearest transit station.

Data Analyses: There are three approaches that are followed in this study.

i. **Descriptive Statistical Analyses:** These are used to describe the basic features of the data in a study. Together with simple graphics analysis, they form the basis of quantitative analysis of data. Descriptive statistics do not allow drawing conclusions beyond the data that have been analyzed or reach conclusions regarding any hypotheses that might have been made, but it is helpful to summarize the group of data, using a combination of tables, graphs and charts, and statistical discussion of the results. This analysis method is used to compare the two samples of Students and Employees based on multiple independent variables to understand the different characteristics of these two samples. This is used to answer some of the research questions – “What are the modal choices of the students and employees in a small-city university setting?”, “What are the influencing factors or determinants of the travel pattern of university population?”, “What are the current attitudes toward public transportation”, and “How employees and students from the same university are different in terms of travel behavior?”

ii. **GIS Analysis:** Geographic Information System analysis does not directly pertain to any specific research question. However, this is used to map the residents' locations based on the addresses provided by the respondents in the survey. Addresses were geocoded in order to locate and analyze the current locations, the different part of Ames that the respondents travel to and from the university on a daily basis, and proximity of the residences from the existing CyRide system. Also, Network Analysis is done to identify the prospective routes based on the geocoded locations.

iii. **Multinomial Logistic Regression Analyses:** Multinomial Logistic Regression is the predictive linear regression analysis to conduct when the dependent variable is nominal with more than two outcomes. It is a model that is used to predict the probabilities of the different possible outcomes of a categorically distributed dependent variable, given a set of independent variables (which may be real-valued, binary-valued, categorical-valued, etc.). The multinomial logit model assumes that each independent variable has a single value for each case and the dependent variable cannot be perfectly predicted from the independent variables for any case. As with other types of regression, there is no need for the independent variables to be statistically independent from each other.

This analysis method is used to analyze how various factors are affecting the travel behaviors in both the samples. This helps to answer the research questions – "How do the factors influence the travel pattern of university population?" and "Is there an observed willingness to shift the travel choice from private cars to public transportation in both the populations? The possible outcomes of this dependent variable are "Yes – to go to the university", "Yes – To go to other activity areas"

and “No – to any of these places”. A hypothesis is assumed in this analysis, that the explanatory variables do impact the travel behaviors and the willingness to change the mode choice to public transportation.

CHAPTER 4: ANALYSES AND RESULTS

Descriptive Statistical Analyses

This analysis includes (i) comparative analyses of demographic attributes of the two samples, and also distribution analysis of both of them individually for some specific variables; (ii) comparative analyses of psychological, behavioral and cultural aspects of the two samples ; and (iii) comparison of other factors such as availability of parking permits, time taken to travel from residence to campus, time of the day to leave for and from campus, proximity of residence to the nearest bus stop, ownership of car and/or motorcycle etc between the two samples. This also includes the analyses of the responses to the questions on the two Dependent Variables, (i) Modes of Travel and (ii) Willingness to Change the Modal Choice to Public Transportation.

Comparative and Distribution Analyses of Demographic Attribute

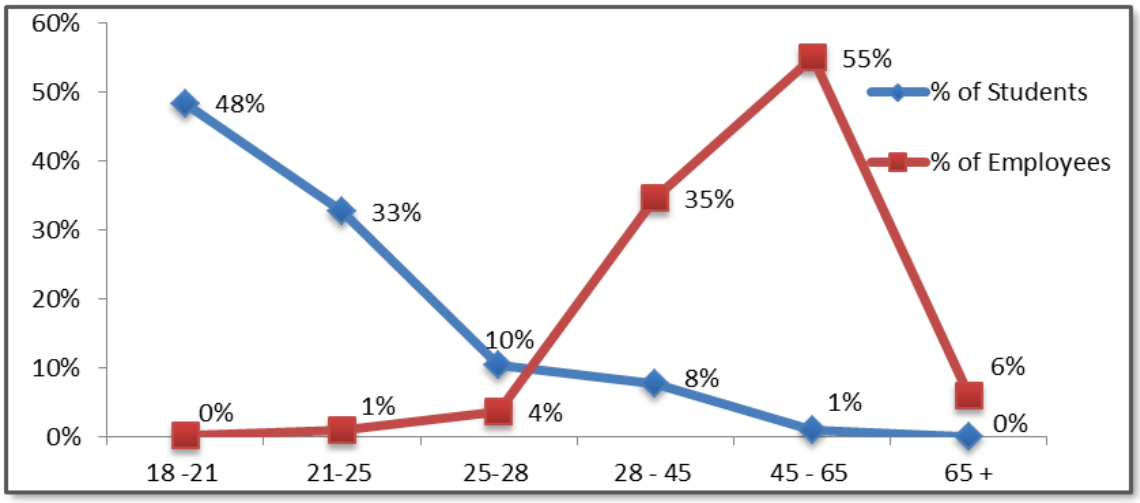


Figure 6: Age Range in Years Students and Employees

The survey results generate the below graph (Figure 6), which shows the distribution of age (in years) of both the samples. Almost half the share of respondents

from the student sample was aged between 10 to 21 years and over 90% of the respondents were less than 28 years. This distribution is strikingly different from that of the sample of employees, where over 95% of the respondents were over 28 years. This difference might have affected the different travel behaviors of the two samples. This relational influence would further be analyzed in the regression analyses, in the following sections. Also, in the students' sample, the average age was found to be approximately 23 years, close to that of the population, which is 22 years. Hence this attribute in this sample is representative of the population. However, in the employees' sample, this is not the case, as the average age in the sample is approximately 48.3 years, about 14 years more than that of the population (34.4 years). This says, the sample is not representative enough of the population and may lead to a bias in its responses.

Data also shows (Figure 7) that the marital status of the two samples is highly different. In case of the students almost 90% of them are unmarried (single or living with partner.) This can be quite logically explained from Fig. x also, as most of the respondents in this sample is very young, in between their late teenage and early twenties. In employees' sample, almost about three quarter of the respondents were married, living with family and / or kids and the rest one quarter includes all of the other three categories. This could possibly tell us, that the responsibilities of the family and households might impact the travel behavior to a great extent in this sample.

Researches show, as mentioned above (in the literature study section), gender influence the travel behavior to a great extent. As we see below (Figure 8), females were over-represented in both the employee and student sample populations. This may indicate a possibility of having more interest or concern in studies of travel behavior in female respondents than the male ones.

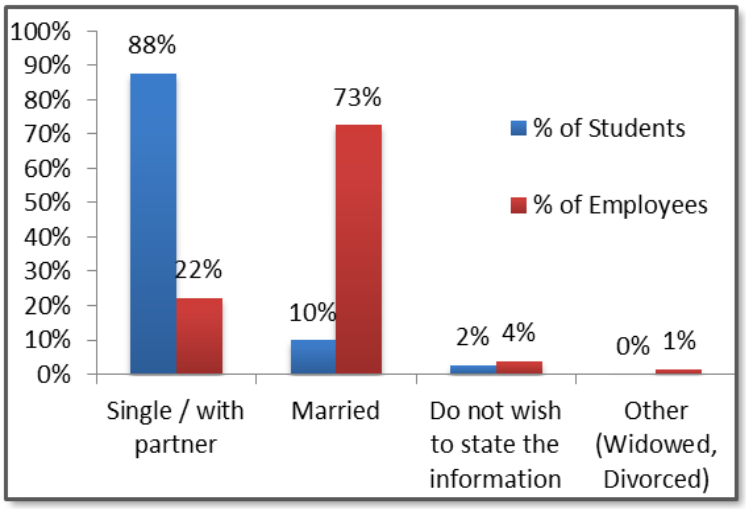
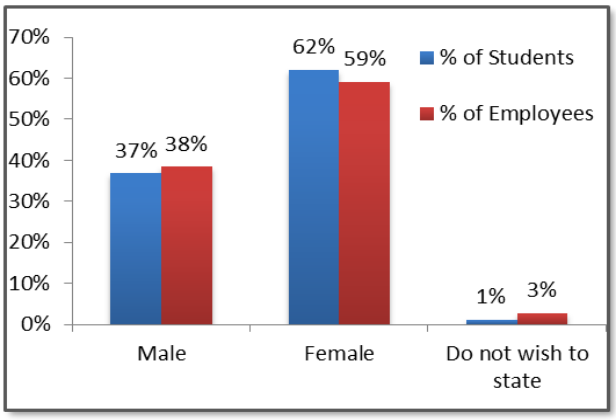


Figure 7: Marital Status of Students and Employees

However, previous researches show, females are more likely to drive to work, and, as we will see later, a major share of travel choices were driving. This confirms the assumption, that, as a majority of the respondents were female, and as from the previous studies we learnt females are more likely to drive, this impacts the responses to the questions on the travel behavior. Looking at the distribution of both the student and employee populations of the university, it can be inferred that the samples were not very well-represented of the populations. In both cases, female respondents were over-represented by about 10 % and 19% in students' and employees' samples respectively. Hence the male respondents were underrepresented by the same proportions. This may, too, lead to a bias in interpreting the travel behaviors in general.



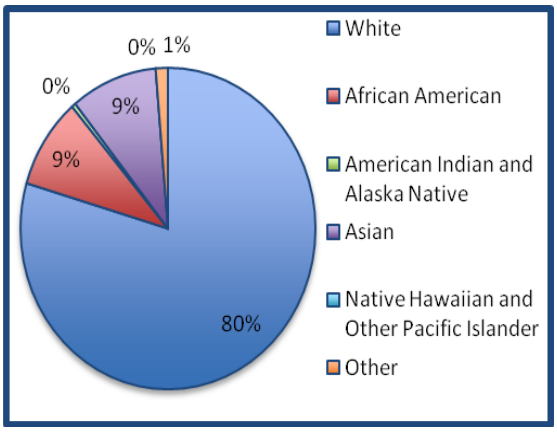


Figure 8: Gender Distribution of Students and Employees

Figure 9: Race of Students

The survey included questions on the race of the students as this too, based on the previous studies, impacts the travel behavior. Researches show, white population shows an inherent culture of automobile dependence. As we see from the above graph (Figure 9), a majority (80%) of the respondents in the student sample were white. This may possibly give a hint to the high percentage of driving as a travel mode choice.

However, question on race was not included in the survey questionnaire for the employees. This is based on the assumptions from the previous researches that, with the increased professional and personal responsibilities and time constraints, travel behavior does not seem to differ much in employees, based on their ethnicity. When compared with the population, white students over-represent the population by about 3%, African-American and Asian students both over-represent by about 6.5%. However, other categories like American Indian and Alaska Native %, Native Hawaiian & Other Pacific Islander % and students with two or more races were under- represented by about 16%. This one again may create a bias in the responses received.

In continuation with the previous questions, students were also asked to state if they are domestic or international students. International students were asked to state their countries of nationality or continents. This study shows, about 11.5% (Figure 10) of the students reported they are from outside US and which closely match the population ratio (10.6%) as well. This shows that for this attribute, the sample closely represents the population. Based on the results, more than half of the students reported were from India and China (Figure 11), and all other countries together shared less than half of the population. Though, it is known, majority of the international students in the US universities are from India and China, its proportion could not exactly be compared with the population.

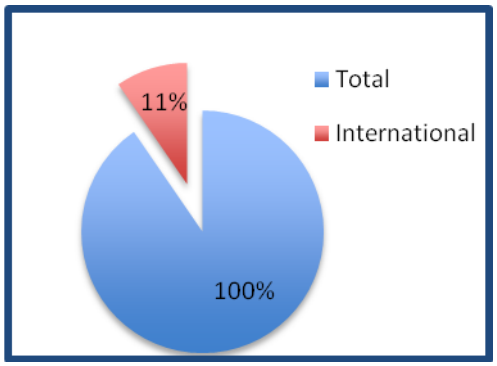


Figure 10: International Students %

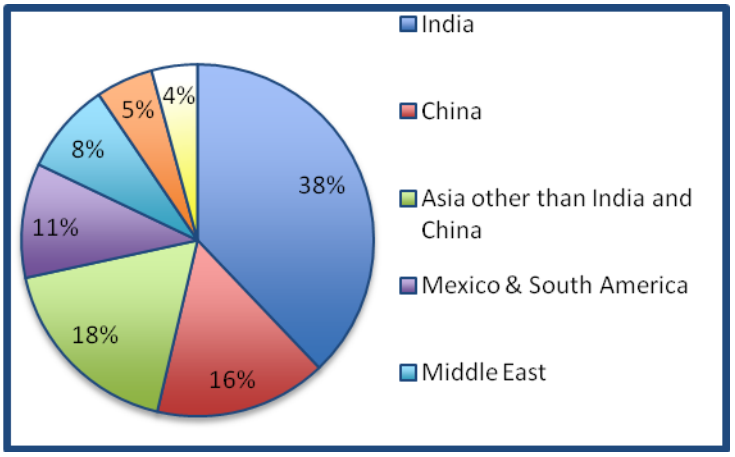
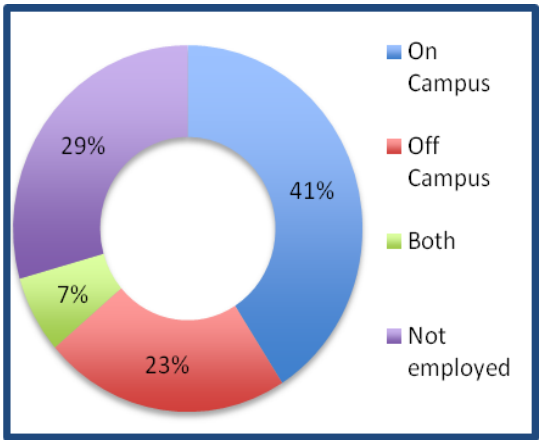


Figure 11: Countries / Continents of Students

Studies show, Employment and Educational Attainment are the two key closely related factors of demographics which impact the travel behavior. When asked about the employment status, about one quarter of the population reported to be unemployed. Later we will see, students were asked if they own or possess any car and / or motorcycle; and only 3% (27 students) do not have any of them. However, as we see from the below graph (Figure 12), about 23% of students are unemployed. Unlike other nations, this proves, ownership or possession of automobile does not directly correlate with the status of the

employment. Over 40% of the student population work on campus. This high percentage may have impacted the responses on question on trip to university, reportedly using alternate mode of transportation.

Almost three quarter (Figure 13), of the students respondents were undergraduates. Literatures reveal, graduate students are more likely to drive to university than the undergraduate ones. This too may have led to the assumption that, with a lesser proportion of graduate students, percentage of students driving to campus has been reported to be lower. However, when compared this with the population, undergraduate students are under-represented by about 14% and the graduate students over-represented by the same proportion. This observation may counter-argue the previous assumption, as more number of graduate student respondents should exhibit higher rate of driving to university.



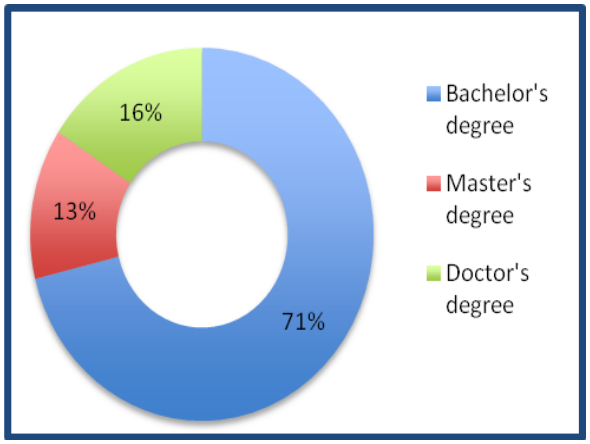


Figure 12: Employment of Students

Figure 13: Educational Attainment of Students

Annual income proves to be an important predictor of travel behavior, as concluded by many earlier researches. When this variable is compared between the two samples, a sharp contrast is observed (Figure 14). Almost about one third of the students responded to have no earning, and over one half of the population reported to earn less than 20,000 USD

per year. None of the students have earning over 40,000 USD per year. This picture is absolutely opposite in case of the employee sample. Approximately 97% of the employees have more than 30,000 USD of annual income and about one-third of the employees have annual earnings from 75,000 – 110,000 USD. As income is one of the key influencing factors for the ownership of automobiles, it is expected to be high in the employee population. Considering other factors in mind such as family and professional responsibilities, and with a much higher income, it is likely to be one of the main reasons to choose to drive to university. None of these samples' results could be compared with the populations to gauge the representativeness, as at the university repository this information was unavailable.

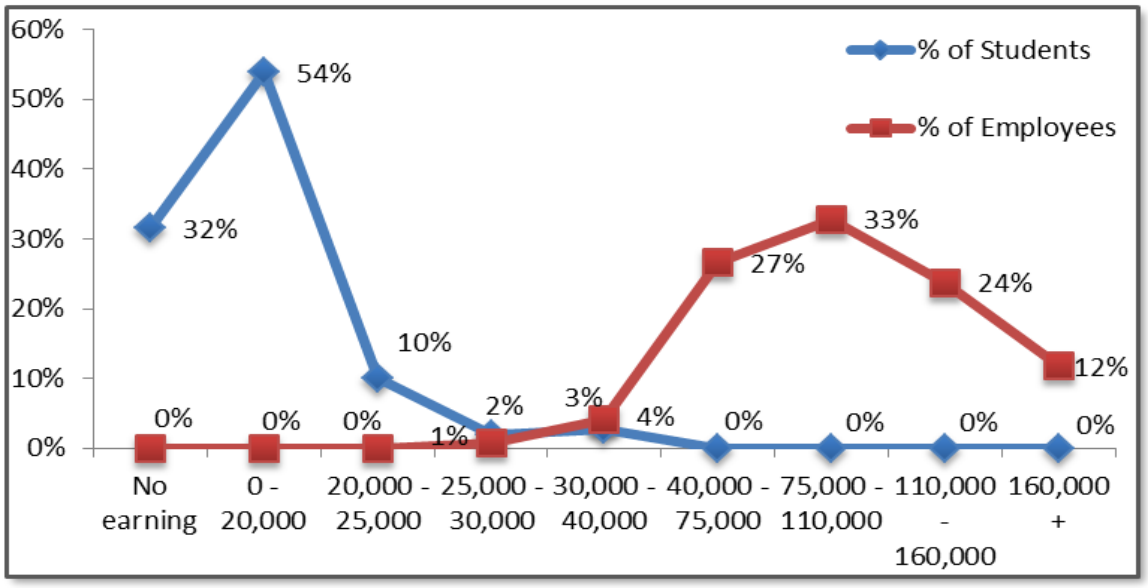


Figure 14: Annual Income of Students and Employees

The surveys conducted asked for the residence addresses of the respondents, to understand how far they travel to university and what the major locations that the respondents come from are. The exact addresses are geo-coded onto maps and will be

discussed later, in GIS analyses. As results show in Figure 15, majority of both the populations reported to come from different parts of Ames. Less than 10% in student sample and about one third of the employee population come from the locations outside Ames. Though this research essentially focuses on CyRide service, which is the city bus system for Ames, it is helpful to look into the share of population that come from outside of Ames. In the students' sample, on-campus students (47.3%) over-represented the population by 12% and consequently, the off-campus students were under-represented. This may have affected the results of the analysis, possibly showing a higher percentage of use of CyRide and lesser proportion of driving that it actually is.

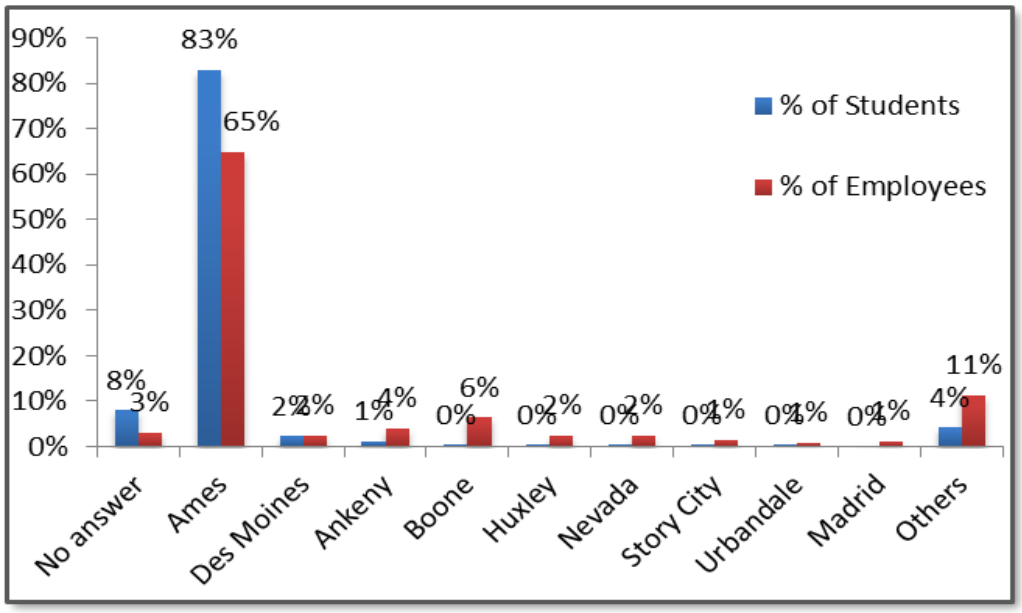


Figure 15: Cities of Current of Students

In addition to the previous question, employees were also asked about their residence type. More than 80% (Figure 16) of the sample reported to have owned residences, and many commented that the home ownership is one of the key reasons, which restrict them from changing their residence locations, even if it's far from the university

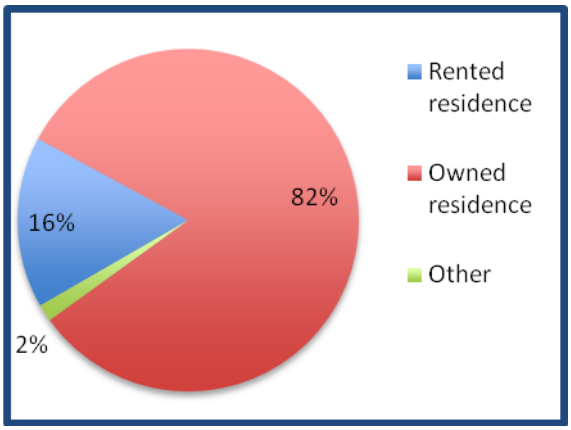


Figure 16: Residence Type of Employees

and necessarily driving from there. Many of them own farmlands or ancestral homes as well, which essentially impacts the travel behavior in the same manner.

Comparative Analyses of Psychological, Behavioral and Cultural Attributes:

Both the surveys asked separate questions on the primary factors that guide or decide to choose the travel mode to the university and other activity areas such as grocery, shopping, recreational or physical activities etc.

The results show that the primary factors of choosing the travel mode to go to the university are vastly different in the students' sample from that of the employees. For students in Figure 17, affordability, lack of parking space, cost of gasoline or cost of vehicle parking seem to some of the major determinants, where these factors are significantly less contributing to the employee sample. These observations are extremely important in order to decide on the policy recommendations.

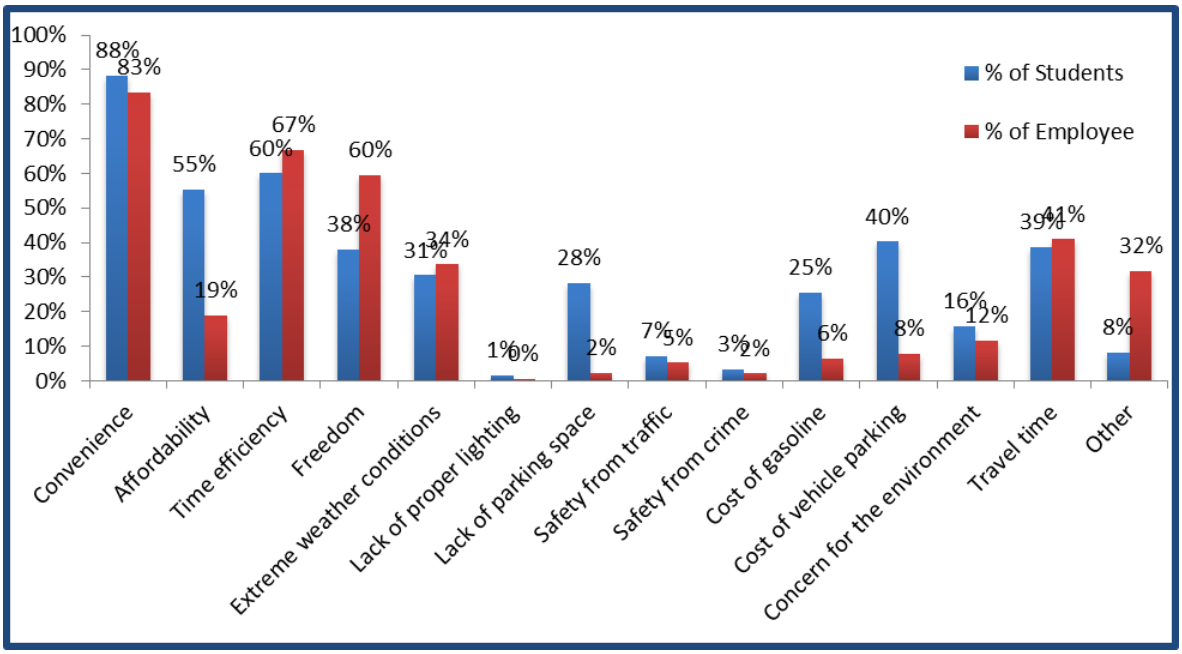


Figure 17: Primary Factors for the Choice of Travel Mode to University for Students & Employees

In contrast with the previous results, Figure 18 shows, the factors which guide to choose the mode of transport to other activity areas are very similar in both the samples. This shows, when the aforementioned constraints like lack of parking space, or cost of vehicle parking are not applicable, both students and employees tend to behave in a similar fashion. This also shows that, various factors that can be changed with newer planning strategies, seems to be less effective for the trips to other areas and much effective for the trips to the university. For the students, the same factors, for example “Affordability”, seem to play role differently when the destinations are different. This may be because, with restricted parking policies, driving is not very affordable for the students. However, having no such constraints, driving is much more affordable to other activity areas. However, these factors impact the travel behavior of the employees in a similar fashion, irrespective of different destinations.

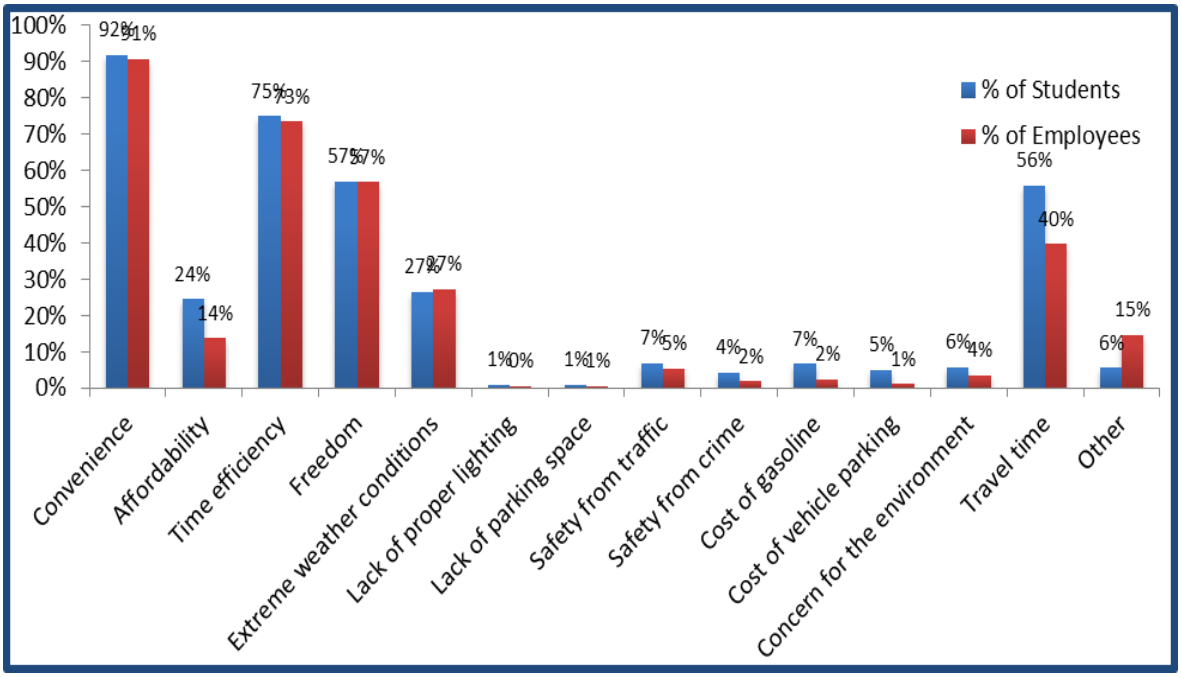


Figure 18: Primary Factors for the Choice of Travel Mode to Other Places for Students & Employees

When the question is specifically asked about the choosing the CyRide service is asked to both the samples, students and employees responded quite differently. Students are observed to choose the CyRide service because of factors like affordability, convenience, time efficiency, extreme weather conditions, lack of parking space, cost of gasoline, cost of vehicle parking, frequency of daily service and distance from the residence to nearest transit stop. As observed in Figure 19, all these factors contribute much less for the employees. It is important to mention here that, many of the respondents in employees sample, did not choose any of the factors mentioned here as they do not at all avail of the CyRide service.

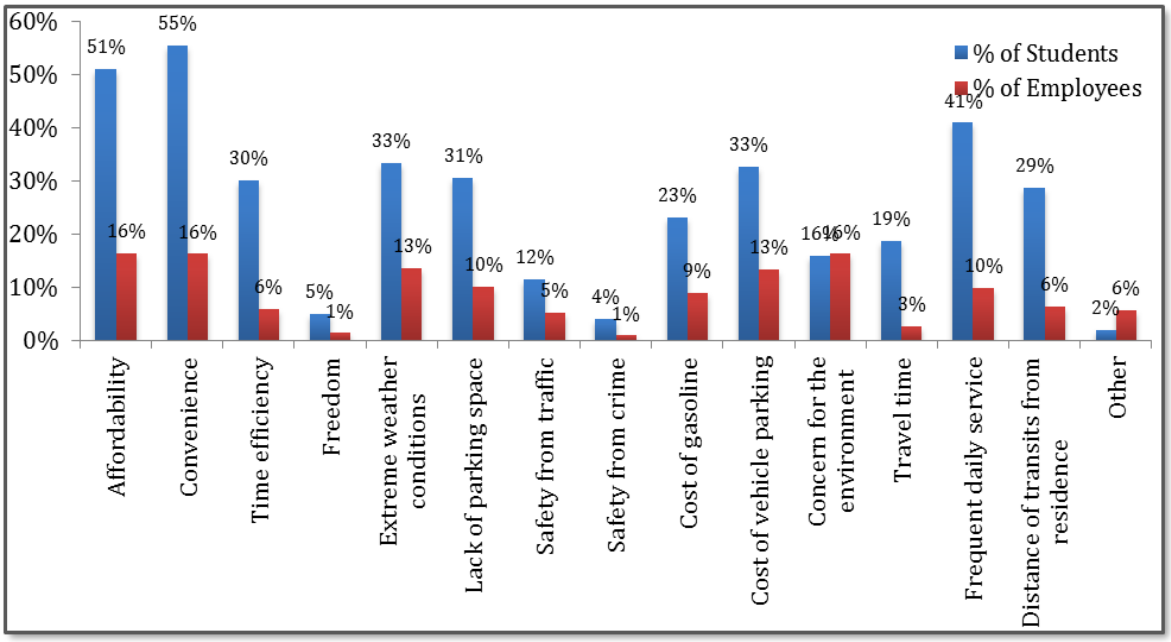


Figure 19: Primary Reasons for Choosing CyRide to Campus for Students & Employees

This study also reveals that factors like distance of the residence from campus, mode of transportation, utilities provided and living with family, friend and partner are some of the key factors for students (Figure 20), which are much less significant for the employees. The fact that a majority of the employees drive to the campus, aforementioned factors are much less important to consider while choosing the residence. As previously mentioned, most of the employees own a home; hence there are necessarily other determinants which guide them to choose their residence.

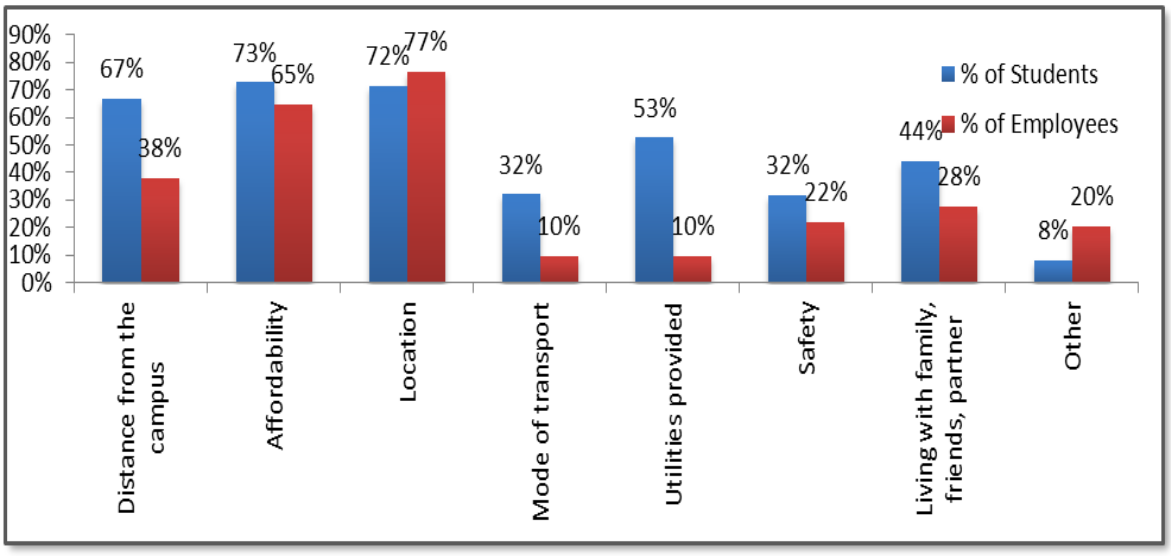


Figure 20: Primary Reasons for Choosing Residence for Students & Employees

About two third of the students expressed their satisfaction in the CyRide service (Figure 21), though for one third of them it does not apply at all. However, for the employees, only 20% expressed their satisfaction, and for about three quarter of the sample it does not even matter. This shows that improved policies may have much lesser impact in the travel behavior of the employees.

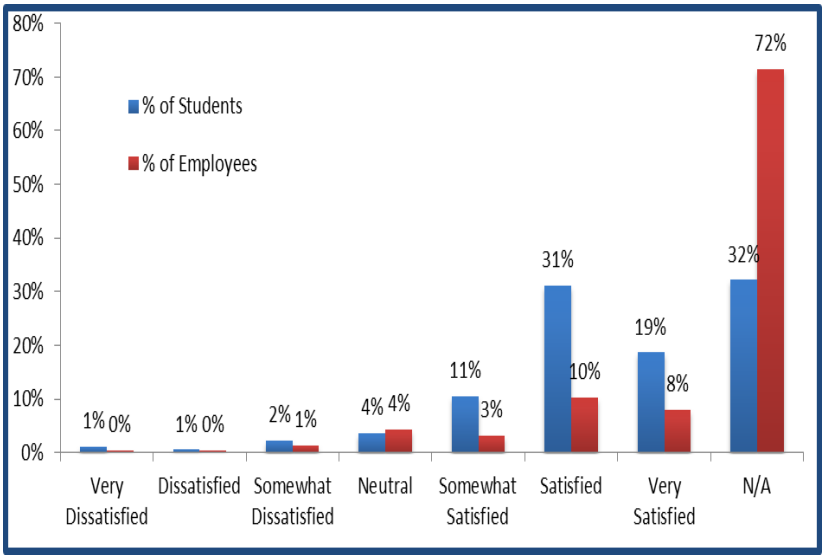


Figure 21: Satisfaction Level with CyRide for Students & Employees

Many reasons are stated to be hindrances in the use of CyRide, as shown in Figure 22. Most of them being similar in both the populations, extreme weather conditions, lack of freedom, distance of residence from the nearest CyRide stop are the key road-blocks for the employees. As mentioned earlier, the fact that many of the employees come from locations far from the university, even Ames, one of the key factors as the distance of residence from the CyRide stop, is an obvious conclusion. For students, however, expressed inconvenience to a great extent, for not having late evening or night bus service. This is more crucial for the graduate students with higher academic responsibilities.

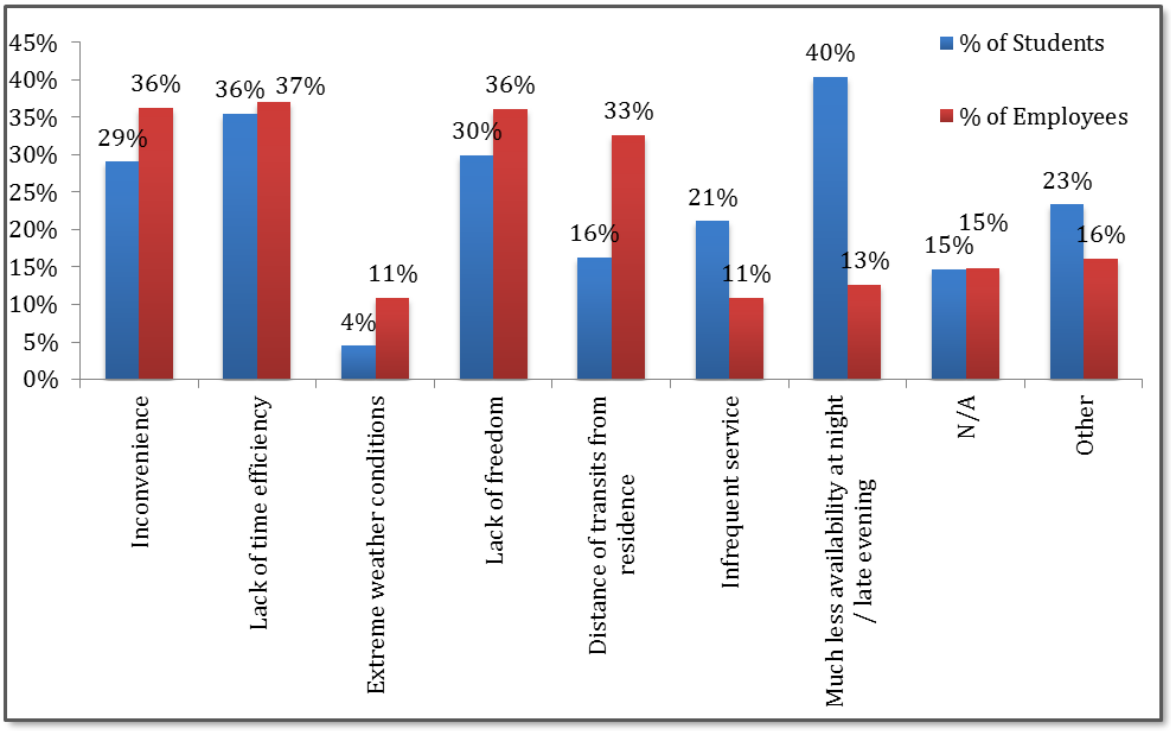


Figure 22: Barriers to Choose CyRide to Campus for Students & Employees

Comparative Analyses of Other Factors:

The parking cost is very cheap both for employees and students, so they can afford to pay it despite paying for the mandatory CyRide service charges each semester. In Figure 23, we see that about one quarter of the students have parking permits from the university, but this percentage in the employee sample is as much as 82%. This can be well explained from the previous results of this study, where preference for driving is greatly observed.

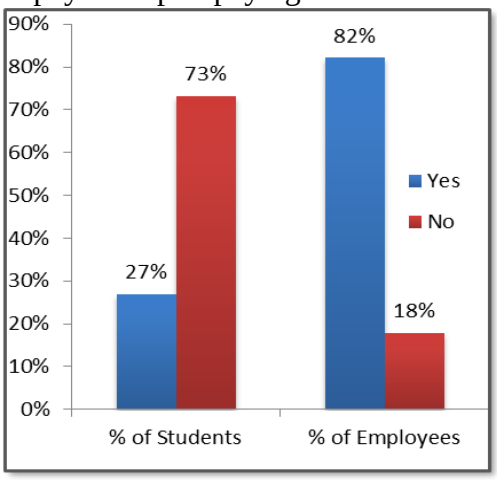


Figure 23: Parking Permit Availability for Students & Employees

Most of students, about 90% reported (Figure 24) to come to university from nearby locations and take 20 minutes or less to reach. This percentage is much less, about 40% for the employees. However, we will see later that about 80% of the employees drive to university. This tells us, even if a significant share of the employees comes from nearby locations, they tend to prefer driving over any other alternate modes. This confirms one of the previous observations, where it was shown that distance is not much a contributing factor in their decision making to choose the travel mode.

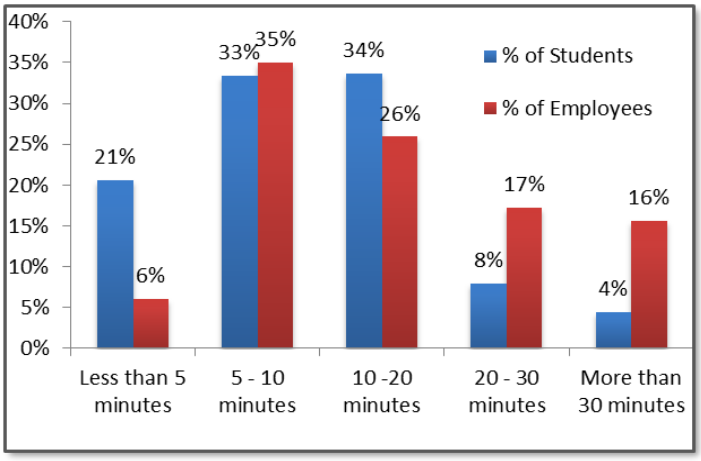


Figure 24: Time Taken To Travel from Residence to Campus for Students & Employees

Close to 90% students leave for the campus before 10 am in the morning (Figure 25) and more than 40% students return from campus after 5.30 in the evening (Figure 26). Surprisingly, CyRide services especially in these parts of the day are much less than that of in the afternoon. For example, since early morning, until 11.30 am, in Brown (6) and Blue (3) routes, there are 2 buses an hour. This frequency almost doubles after 11.30 am, until 6 pm, when there are at least 3 to 4 buses an hour. Most of the routes have no or very infrequent service after 6 / 6.30 pm in evening.

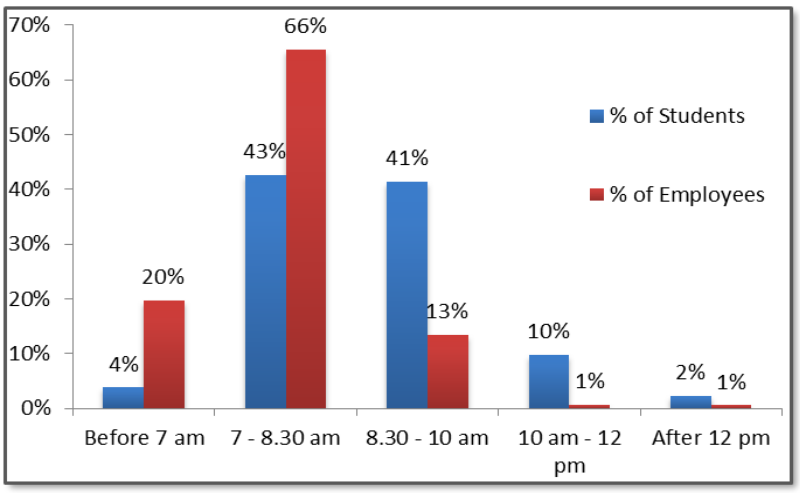
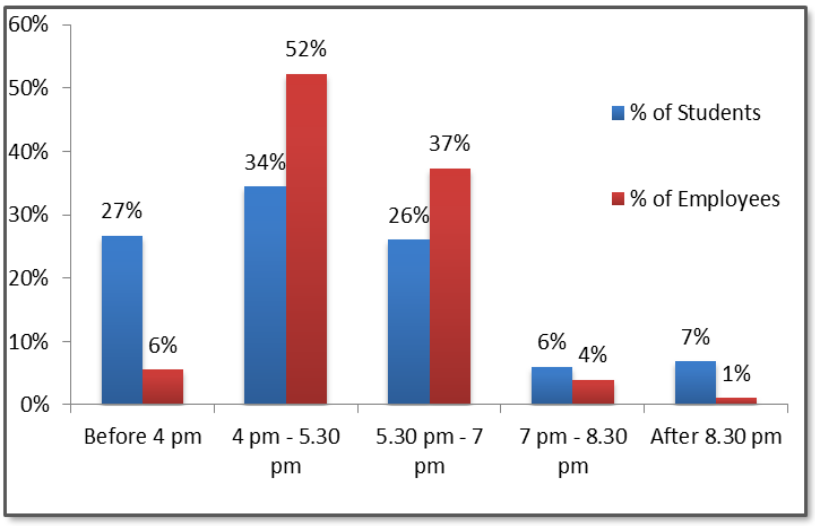


Figure 25: Time to Leave for University for Students & Employees



This fact and the below results on Figure 25 and Figure 26, confirms the observation, that showed infrequent bus service to be a key difficulty to use CyRide.

Figure 26: Time to Leave From University for Students & Employees

Based on the results in Figure 20 and 27, it shows that majority of the students try to live close to transit stops and this factors guide them choose their residence to a great extent. This also validates that a very small portion of students mentioned this factor as a difficulty in using CyRide, as for most of them; this factor does not seem to exist.

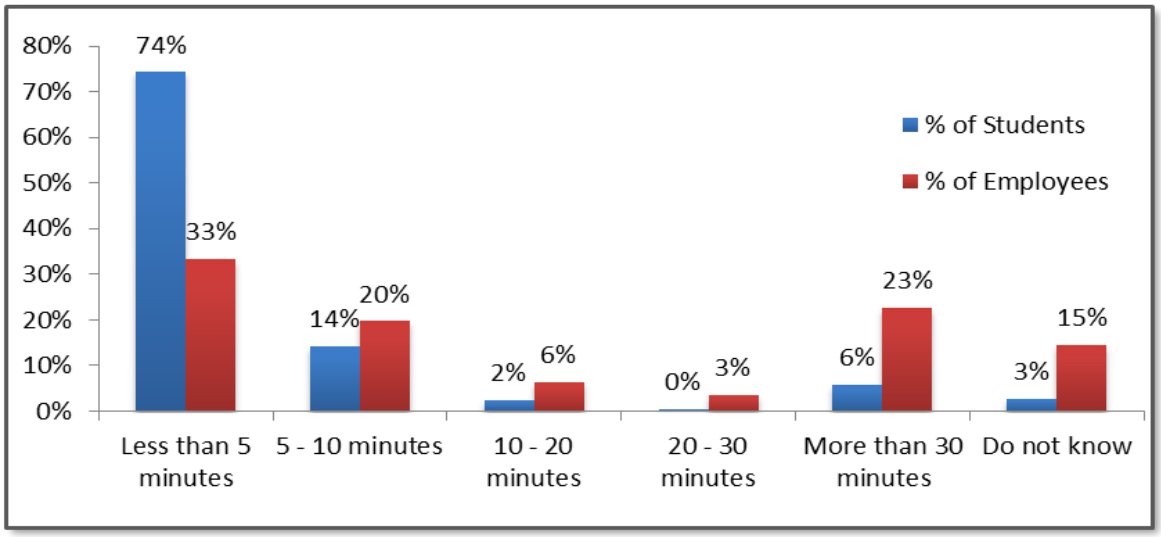
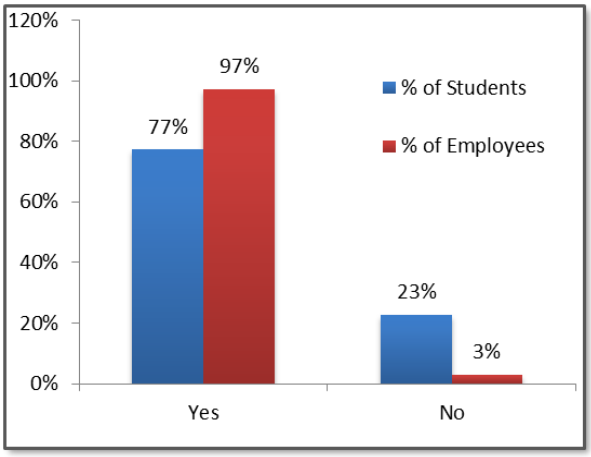


Figure 27: Walking Time Taken to Reach Nearest CyRide Stop for Students & Employees



Many previous researches claim that ownership of a car or a motorcycle would necessarily make the owners drive. Where it seems to be true in case of travel to other activity areas, it does not hold good for the trips to university.

Figure 28: Possession of Car or Motorcycle for Students & Employees

From Figure 28 and Figure 29, we see that majority of both the population have their own cars and / or motorcycles, even more than one. However, despite having this ownership of automobile for 77% of student, many choose not to drive and take other modes of transport to university. This supports some previous parallel researches, which stated, proving a suitable alternate transport strategies like TDM help impacting and eventually changing the travel behavior.

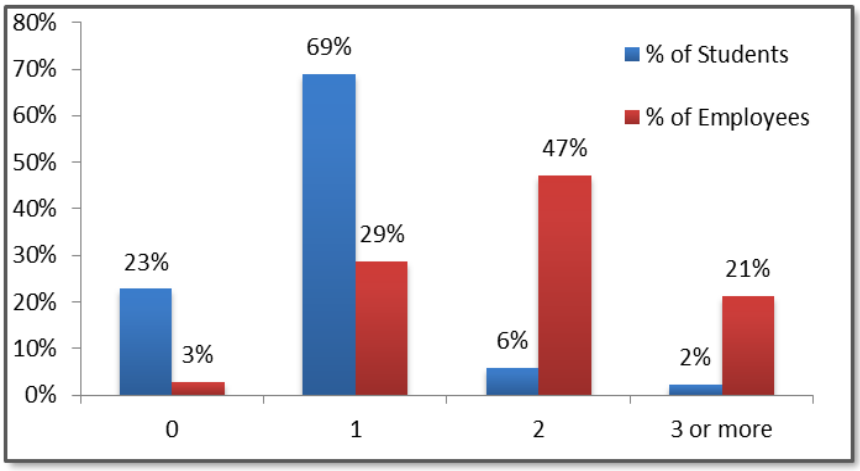


Figure 29: Number of Car or Motorcycle Owned by Students & Employees

Different Modes of Travel:

Figure 30 and Figure 31 show that the modes of travel differ significantly between the two samples, when the destination is to the university. As mentioned earlier, majority of the employees drive to campus and less than one quarter of the students do the same. The share of students, who take public transportation only or other combination of modes including public transportation to go to campus, is the highest (38%).

Students are also observed to walk or biking to campus much more than the employees. This can be a cumulative effect of all the demographic and behavioral factors discussed above.

Unlike the previous observation, other factors remaining unchanged, the travel behavior of both the samples are somewhat comparable, when the destination is anywhere else but the university. Both students and employees mostly drive and this may be due to many aforementioned factors like less frequent services after university hours, distance of transit stop from the activity area, safety etc. Also, as other places have much less stringent parking regulations, driving to these areas are much more affordable and convenient.

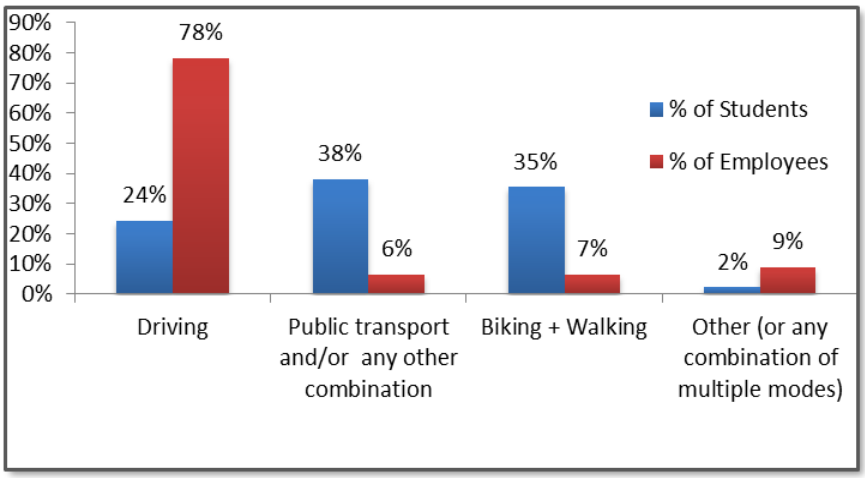


Figure 30: Different Travel Modes to University for Students & Employees

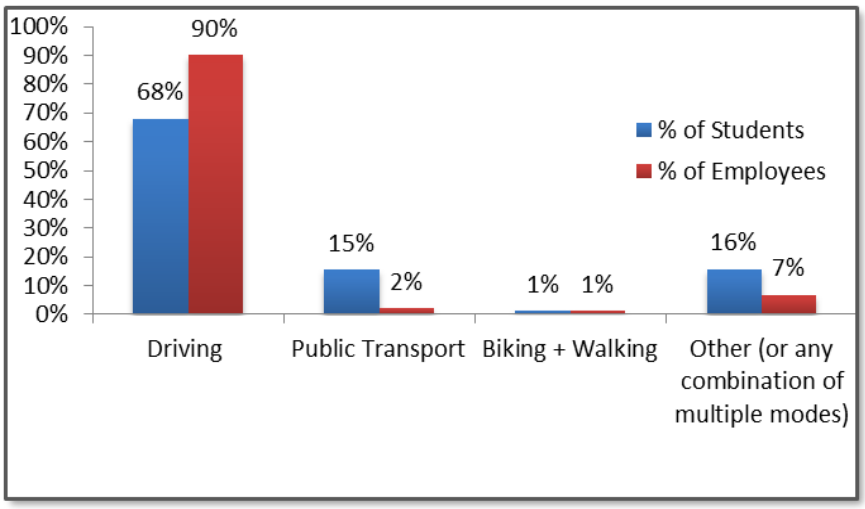


Figure 31: Different Travel Modes to Other Places for Students & Employees

From these two graphs (Figure 30 and Figure 31), one of the key research questions can be answered. The different modal choices of the students and employees in a small-city university setting are:

1. Driving – Most preferred
2. Public Transportation (Bus, in this study) or combination of multiple modes including Public Transportation –Most preferred by the students
3. Biking
4. Walking
5. Combination of multiple modes which does not include Public Transportation – Least preferred by the students

Willingness to Change the Travel Choice to Public Transportation:

Figure 32 shows, whether students or employees would consider using CyRide service, if the necessary measures are taken to address the difficulties, due to which they currently do not avail of the service. Surprisingly, almost half of both the students and employees expressed unwillingness to shift their travel modes to CyRide. This confirms the psychological and attitudinal aspects of travel behaviors in many previous researches. These studies conclude that travel behaviors are as much cultural and psychological, as much as situational. Even if efficient strategies are implemented and services are made available, people might not change their travel behavior. According to them, while

addressing the issues, psychological, cultural and emotional aspects are also required to be taken into consideration, while recommending the planning policies.

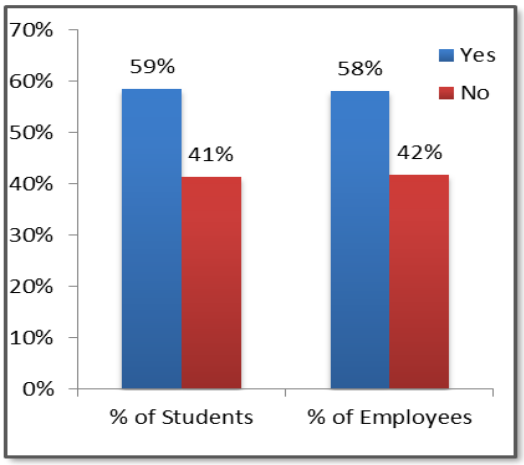


Figure 32: Population Who Consider Using CyRide with Changes for Students & Employees

The key changes needed that can make both students and employees to use CyRide were shown in Figure 33. Students suggested more frequent daily service, new routes, time taken to reach the destination, less crowded buses, and services after usual business hours are the key changes that should be implemented in order to use CyRide.

It is important to mention that, majority of the employees do not respond to this question. This is expected also from the previous results (Figure 21), where over 70% of them stated the CyRide service does not apply to their travel. However, some who replied to this question, state more frequent daily service, new routes, and service closer to residence, time taken to reach the destination, and services after usual business hours to be the reasons to consider.

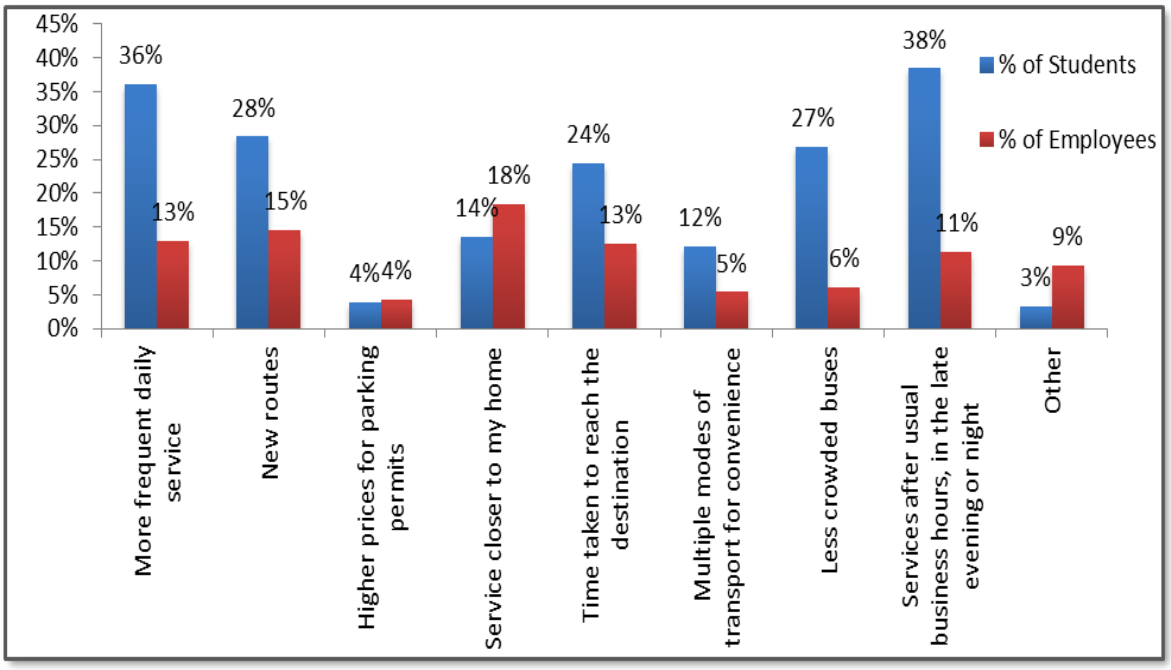


Figure 33: Changes Required Considering Using CyRide with Changes for Students & Employees

GIS Analysis

This study includes limited applications of GIS Analysis, to understand how students and employees are located in Ames. In the two surveys, respondents were asked to state their address of residence, or nearest street intersections, or the ZIP Code. As this was a voluntary participation, and address fields were not mandatory in order to complete the surveys, unfortunately, number of complete addresses found was much less than the total number of responses received. For employees, only 765 addresses could be located, and for students this count was 781. Out of all these addresses, 561 addresses of employees and 731 addresses of students were located in Ames. On ArcGIS 10.2, all these addresses were geocoded and located on Ames map along with the existing CyRide routes (Figure 34 and Figure 35).

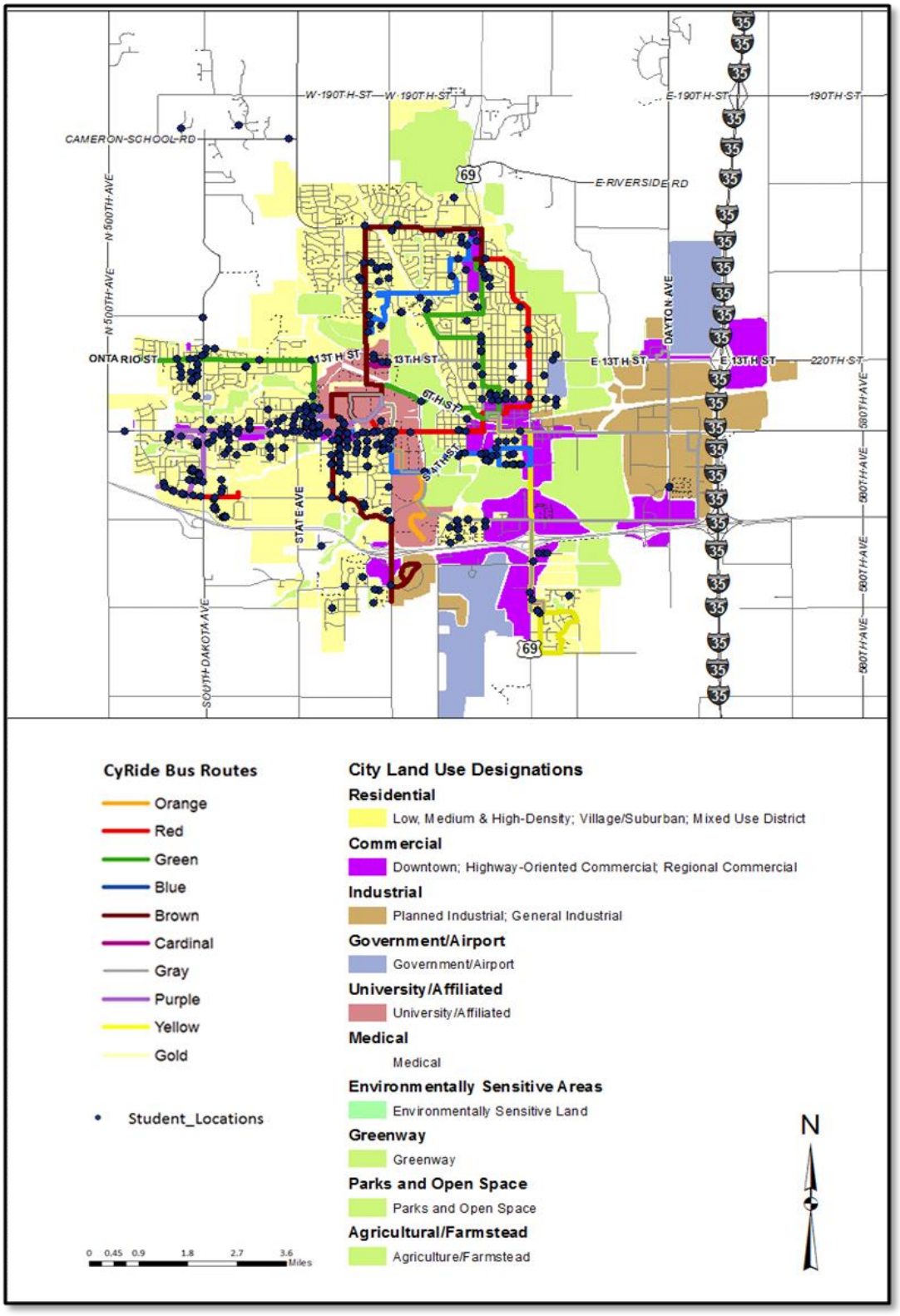


Figure 34: Students' Residence Locations in Ames

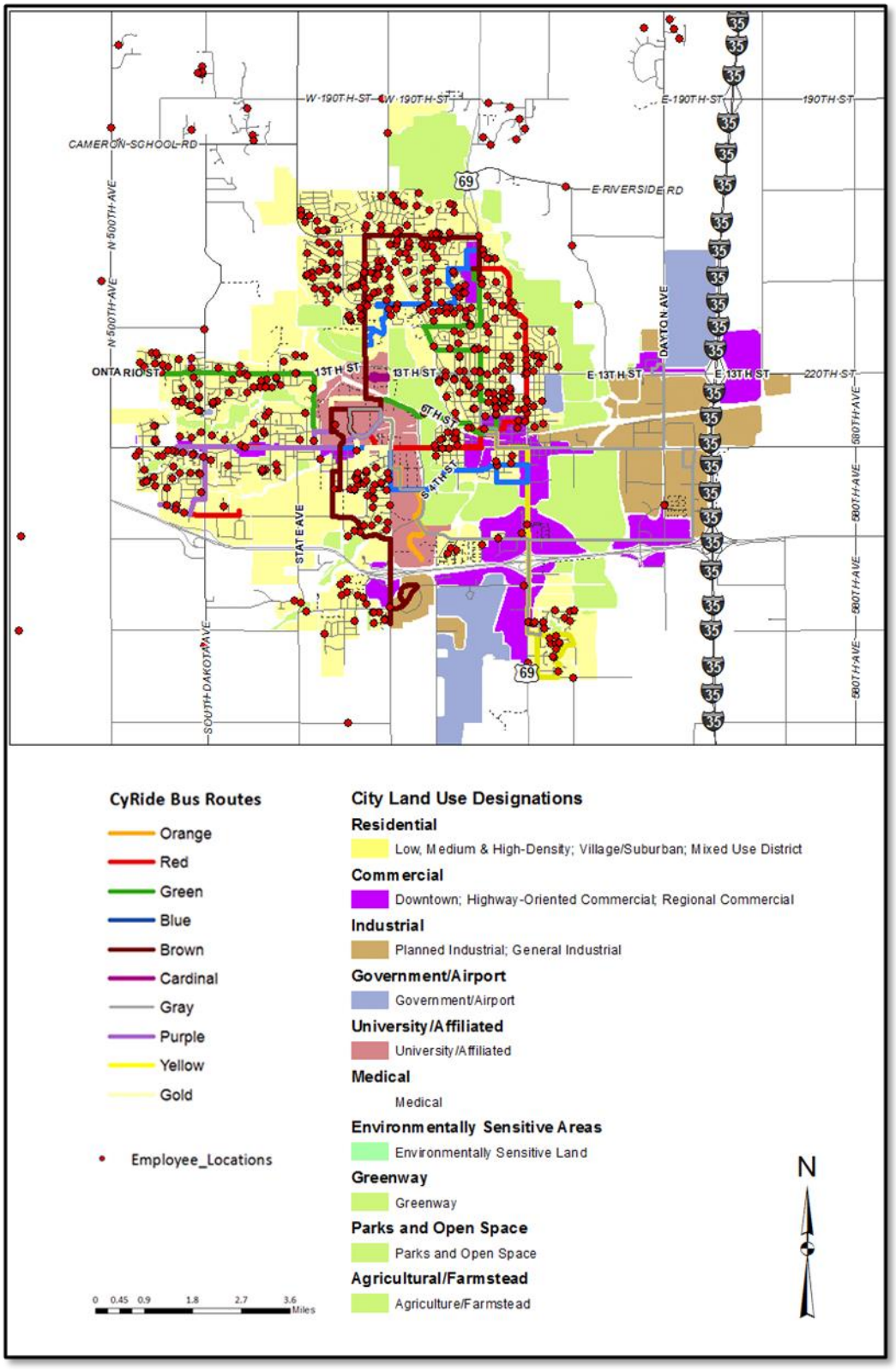


Figure 35: Employees' Residence Locations in Ames

The results in this study revealed that, many respondents (both students and employees) live far from the nearest bus stops of any CyRide route. To analyse more accurate, network analysis is done (Figure 36 and Figure 37) to better understand the distance of roads from the nearest bus stop. Three level of network analysis is included with 01 mile, 0.25 mile and 0.5 mile distance from all CyRide stops. This is done with the assumption that, a person would not walk more than half a mile to take bus to go to university for his/her convenience. The above network analysis results show that some of the residential areas where multiple students and employees come from are not close to CyRide stops which impede the usage of the same.

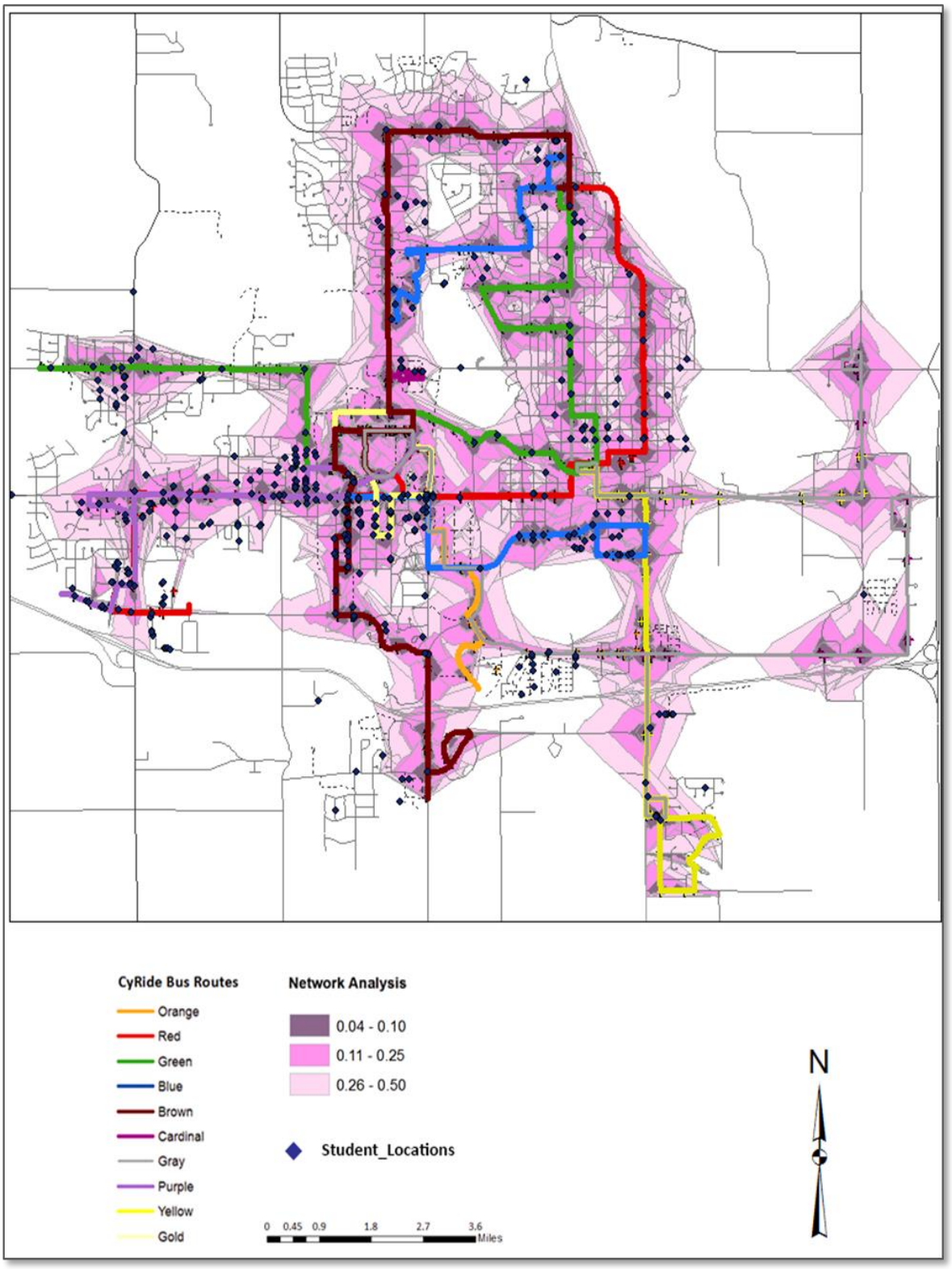


Figure 36: Network Analysis of Roads from the Nearest CyRide Bus Stops with Students' Residences

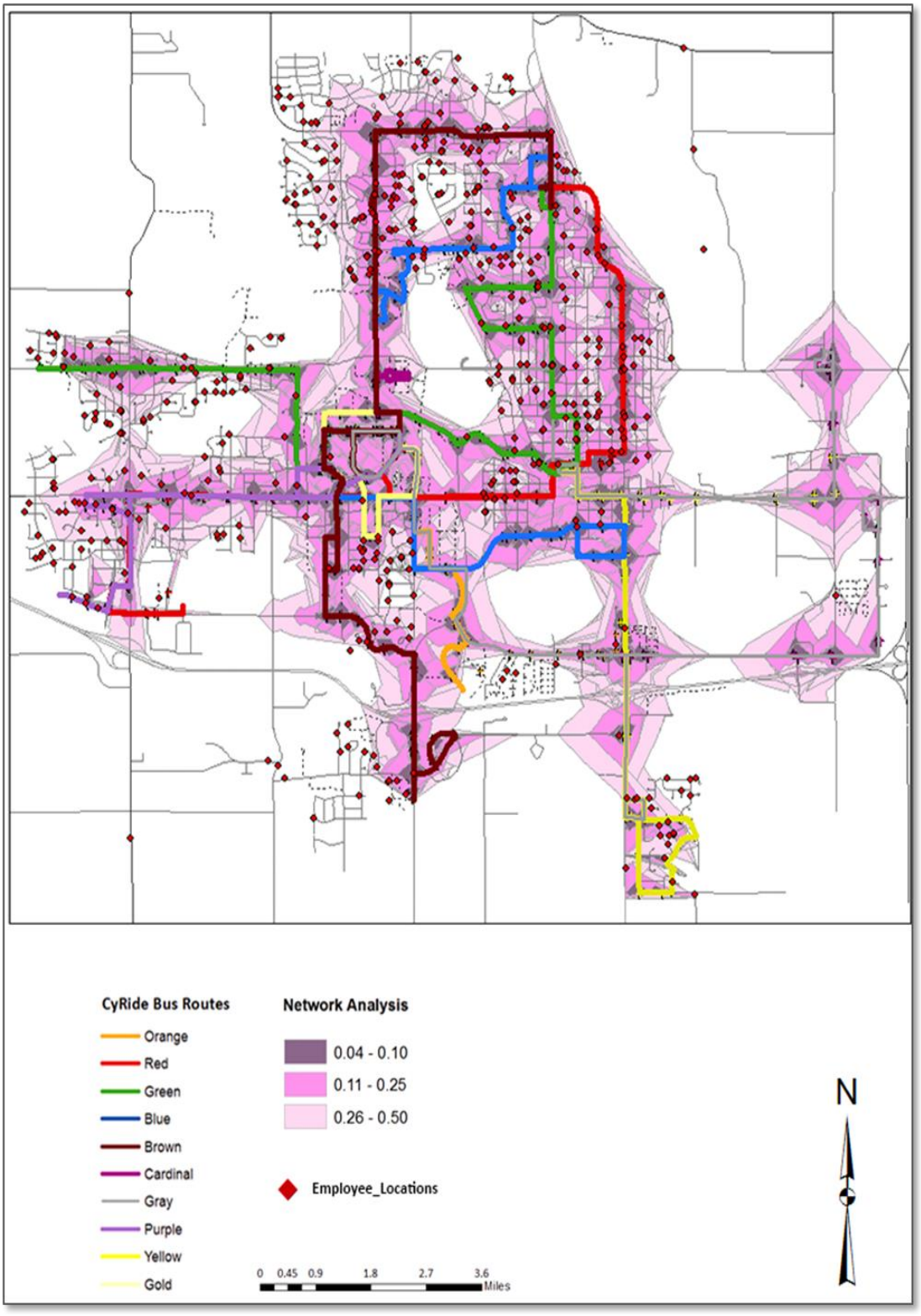


Figure 37: Network Analysis of Roads from the Nearest CyRide Bus Stops with Employees' Residences

However, looking at the below table (Table 3), we see that, some of the routes are underutilized such as Blue (3), Yellow (5), Pink (10) or Gold (22), though they operate significant number of trips per year. Some of those trips can be recommended to be reduced and services in some other routes (for example Brown) can be increased to cater to a larger population. It is also important to observe, that Blue and Yellow routes run through the designated residential areas, however, the number of passengers per trip is very low. Pink route goes through the industrial zone, so fewer numbers of passengers per trips can be explained. Another important observation from the above figures is, many students and employees live on the route 23 (Orange). And the number of passengers per trips on this route is the maximum. However, there is no service available on this route on weekends.

Table 3: Passengers per Trip in Each Route of CyRide

Route	Number of Trips Per Year	Number of Passengers Per Year	Number of Passengers Per Trip
1 Red	48384	1381107	29
2 Green	21408	379689	18
3 Blue	31248	141477	5
5 Yellow	4080	24422	6
6 Brown	26208	666662	25
7 Purple	1680	36144	22
10 Pink	1440	3625	3
21 Cardinal	21360	370991	17
22 Gold	7680	76198	10
23 Orange	12240	1722750	141

Multinomial Logistic Regression Analysis

To analyze the influence of the explanatory (independent) variables, an appropriate regression model should be adapted. Because, the possible outcomes of the dependent variables were nominal and not continuous in nature (i.e. the outcomes are categorical and cannot be ordered in any logical manner), Multinomial Logistic Model is considered. For the two types of dependent variable for both the students and employee populations, in total four MLMs were developed. The first two study the effect of the explanatory variables on the marginal utility of individual mode choices such as public transit, biking/walking/carpooling/any other combination of modes which does not include public transportation, relative to the reference—driving alone, for the two populations. The second two focus on the effect of the explanatory variables on the marginal utility of willingness in changing the mode of transport, in both the populations. Given the total number of complete responses that can be used to construct variables for MLMs is relatively small ($N<1000$), the likelihood ratios chi-square with p-values < 0.05 tells us that these models as a whole fit significantly better than an empty model (i.e., a model with no predictors).

The Null Hypothesis that is assumed in this analysis is that all of the regression coefficients in each model are equal to zero. Statistically put, if the dependent variable of a model is Y and X1, X2,…..,Xn are the explanatory variables in that model, the equation of this model will be $Y=\beta0 + \beta1X1 + \beta2X2 + ….. + \betanXn$, where the β's are the coefficients of the independent variables. Then the null hypothesis assumes that all the β's are equal to 0. In other words there is no effect of the predictor or independent variables. The confidence level is taken as 95%, thus the alpha is equal to (1 - 0.95) or 0.05. SPSS 22, a popular social statistical software package was used to generate the MLM results and the

results are presented in Tables 4, 5, 6, 7 and Tables 8 (Appendix B1), 9 (Appendix B2), 10 (Appendix B3), and 11 (Appendix B4). The coefficients in Tables 4, 5, 8 & 9 show the effects of the explanatory variables on the marginal utility of alternative mode choices such as public transit, carpool, biking/walking and telecommuting relative to the reference—driving-alone. The coefficients in Tables 6, 7, 10 & 11 show the effects of the explanatory variables on the marginal utility of willing to change the mode choice to public transit, relative to the reference—unwillingness. Based on the results, we reject the Null Hypothesis, implying that some of the explanatory variables have an impact on both the dependent variables at $\alpha = 0.05$.

Factors that Influence the Travel Mode Choice:

The dependent variable in this analysis has three outcomes, which are (i) public transportation or any combination of modes including public transportation, (ii) combination of other modes like walking, biking, carpooling or any other which does not include public transit, and (iii) Driving. For convenience, we will disregard the explanatory variables which are not significant in this results in Table 8 and Table 9 (p value or level of significance is less than 0.05). Based on the results of the level of significance in these analyses, we can say, the Null Hypothesis is rejected, as some of the independent variables contribute to the choice of travel modes.

Results of Table 4 shows that for students, the factors, which significantly impact the travel behavior are, Availability of Parking Permit, Time Taken to Reach Campus from Residence, Walking Time Taken to Reach the Nearest CyRide Stop from Residence, Affordability, Freedom, other factors like Lack of Proper Lighting, Lack of Parking Space,

Safety from Traffic, Safety from Crime, Cost of Gasoline, Concern for the Environment, Distance from Campus, Mode of Transportation Available, Convenience, Extreme Weather Conditions, Frequent Daily Service, Cities of Residence, Age, Race, Possession of Car of Motorcycle and the Count of the Same. Surprisingly, variables like Employment, Income, or Educational attainment do not significantly impact the choice of travel.

Table 4: Likelihood Ratio Tests for Modal Choices for Students

	Model Fitting Criteria	Likelihood Ratio Tests	
Effect	-2 Log Likelihood of Reduced Model	Chi-Square	Sig.
Intercept	794.971[a]	.000	.
Parking Permit Availability	801.340	6.369	.041
Time Taken to Go to Campus	848.716	53.745	.000
Time to Leave for Campus	803.243	8.272	.407
Time to Leave from Campus	797.565	2.594	.957
Walking Time to Reach Nearest Transit	846.593	51.622	.000
Primary Reasons for Mode Choice - Convenience	795.706	.735	.693
Primary Reasons for Mode Choice - Affordability	829.393	34.422	.000
Primary Reasons for Mode Choice – Time Efficiency	800.321	5.350	.069
Primary Reasons for Mode Choice – Freedom	889.987	95.016	.000
Primary Reasons for Mode Choice – Weather, Safety, Lack of Parking Space, Lack of Lighting	821.432	26.461	.000
Primary Reasons for Mode Choice – Cost of Parking Space	796.707	1.736	.420
Primary Reasons for Mode Choice – Cost of Gas, Concern for Environment	804.182	9.211	.010
Primary Reasons for Mode Choice – Travel Time	798.421	3.450	.178
Primary Reasons for Mode Choice – Other	798.051	3.080	.214

Primary Reasons for Residence Choice – Distance from Campus	826.626	31.655	.000
Primary Reasons for Residence Choice – Affordability	796.675	1.704	.426
Primary Reasons for Residence Choice – Location	797.687	2.716	.257
Primary Reasons for Residence Choice – Utilities Provided	795.659	.688	.709
Primary Reasons for Residence Choice – Living with family, friends, partner	795.283	.312	.856
Primary Reasons for Residence Choice – Mode of Transport Available, Safety	802.098	7.127	.028
Primary Reasons to Choose CyRide– Affordability	799.089	4.118	.128
Primary Reasons to Choose CyRide– Convenience	809.676	14.705	.001
Primary Reasons to Choose CyRide– Time Efficiency	797.506	2.535	.281
Primary Reasons to Choose CyRide– Extreme Weather Conditions	810.046	15.075	.001
Primary Reasons to Choose CyRide– Lack of Parking Space	795.663	.692	.708
Primary Reasons to Choose CyRide– Cost of Gasoline	797.638	2.667	.264
Primary Reasons to Choose CyRide– Cost of Parking	796.510	1.539	.463
Primary Reasons to Choose CyRide– Distance of Transit from Residence	795.690	.719	.698
Primary Reasons to Choose CyRide– Frequent Daily Service, Freedom & Safety	799.981	5.010	.082
Residence Location	825.740	30.769	.058
Age	808.518	13.547	.035
Gender	798.933	3.962	.411
Relationship Status	800.269	5.298	.258
Race	820.481	25.510	.001
Country/Continent of Residence	810.121	15.150	.368
Educational Attainment	802.808	7.837	.098

Possession of Car/Motorcycle	805.168	10.197	.006
Number of Car/Motorcycle Owned	813.443	18.472	.005
Employment Status	803.604	8.633	.195
Annual Income	801.102	6.131	.633

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

From Table 8 (Appendix B1), we see that students prefer CyRide and other modes of travel over driving if they do not have parking permits. This positive effect to use alternate mode is more for CyRide than other modes. The effect of time taken to go to campus is positive for both CyRide and other modes, and this effect is most pronounced when the time taken is between 15 to 25 minutes. But when it goes beyond 25minutes, students prefer driving. The effect of time taken to go to the nearest bus stop is positive for CyRide compared to driving, but it negatively influences use of other modes, compared to driving, if time taken is more than 5 minutes. It is also observed that affordability discourages driving and encourages using both CyRide and other modes. However, freedom discourages using bus and other modes, and encourages driving. Similarly we see that factors like lack of proper lighting, lack of parking space, safety from traffic, and safety from crime together negatively impact bus use and use of other modes and increases driving. Factors like cost of gasoline and concern for the environment impact significantly and encourage bus and other modes use a lot more than driving. However, distance from campus does not significantly impact CyRide use, but quite significant in using other modes, and encourage the same. Mode of transport available and Safety together slightly

affect the mode choice but not significantly. Students have expressed that convenience is a significant reason for which they are greatly discouraged to use bus, but other modes including and walking seem to be much more convenient for them. Extreme weather conditions are not important in case of using bus, but positively significant in using combination of modes. Age, as a whole, does not seem to be much contributing to the mode choice. However, use of public transport of other modes gradually decreases with increase in age, but very slightly. While all other races show a preference in driving, White and African Americans being the most, Asians show a high propensity to use bus and other alternate modes. An insignificant impact of possession of car or motorcycle is observed which driving over other choices.

Results of Table 5 shows that for employees, very less explanatory variables seem to be significant in influencing in travel, and they are, Availability of Parking Permit, Time Taken to Reach Campus from Residence, Time Efficiency, Cost of Gasoline, Concern for the Environment, and Distance from Campus. Variables like Income, Gender etc do not significantly impact the choice of travel.

Table 5: Likelihood Ratio Tests for Modal Choices for Employees

	Model Fitting Criteria	Likelihood Ratio Tests	
Effect	-2 Log Likelihood of Reduced Model	Chi-Square	Sig.
Intercept	337.186[a]	.000	.
Parking Permit Availability	348.962[b]	11.776	.003
Time Taken to Go to Campus	393.374[b]	56.189	.000
Time to Leave for Campus	340.291[b]	3.105	.928
Time to Leave from Campus	344.122[b]	6.936	.544

Walking Time to Reach Nearest Transit	338.728[b]	1.542	.957
Primary Reasons for Mode Choice - Convenience	338.114[b]	.928	.629
Primary Reasons for Mode Choice - Affordability	341.707[b]	4.521	.104
Primary Reasons for Mode Choice – Time Efficiency	344.208[b]	7.022	.030
Primary Reasons for Mode Choice – Freedom	338.286[b]	1.100	.577
Primary Reasons for Mode Choice – Weather, Safety, Lack of Parking Space, Lack of Lighting	338.431[b]	1.245	.537
Primary Reasons for Mode Choice – Cost of Parking Space	337.222[b]	.036	.982
Primary Reasons for Mode Choice – Cost of Gas, Concern for Environment	426.981[b]	89.795	.000
Primary Reasons for Mode Choice – Travel Time	337.633[b]	.447	.800
Primary Reasons for Mode Choice – Other	338.887[b]	1.701	.427
Primary Reasons for Residence Choice – Distance from Campus	356.799[b]	19.613	.000
Primary Reasons for Residence Choice – Affordability	337.831[b]	.646	.724
Primary Reasons for Residence Choice – Location	337.187[b]	.001	1.000
Primary Reasons for Residence Choice – Utilities Provided	341.090[b]	3.905	.142
Primary Reasons for Residence Choice – Living with family, friends, partner	337.243[b]	.057	.972
Primary Reasons for Residence Choice – Mode of Transport Available, Safety	337.726[b]	.540	.763
Primary Reasons to Choose CyRide– Affordability	337.931[b]	.745	.689
Primary Reasons to Choose CyRide– Convenience	340.019[b]	2.833	.243

Primary Reasons to Choose CyRide– Time Efficiency	337.234[b]	.048	.976
Primary Reasons to Choose CyRide– Extreme Weather Conditions	338.827[b]	1.641	.440
Primary Reasons to Choose CyRide– Lack of Parking Space	337.549[b]	.363	.834
Primary Reasons to Choose CyRide– Cost of Gasoline	337.200[b]	.014	.993
Primary Reasons to Choose CyRide– Cost of Parking	338.110[b]	.924	.630
Primary Reasons to Choose CyRide– Distance of Transit from Residence	339.606[b]	2.420	.298
Primary Reasons to Choose CyRide– Frequent Daily Service, Freedom & Safety	337.241[b]	.055	.973
Residence Location	352.491[b]	15.306	.641
Age	339.922[c]	2.736	.950
Gender	337.479[b]	.293	.990
Relationship Status	340.842[b]	3.656	.723
Possession of Car/Motorcycle	337.186[a]	.000	.
Number of Car/Motorcycle Owned	337.406[b]	.220	.994
Annual Income	340.016[b]	2.830	.945

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model.

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

b. Unexpected singularities in the Hessian matrix are encountered. This indicates that either some predictor variables should be excluded or some categories should be merged.

c. There is possibly a quasi-complete separation in the data. Either the maximum likelihood estimates do not exist or some parameter estimates are infinite.

From Table 9 (Appendix B2), we see that employees are much more likely to drive, and significantly choose driving over using bus or any other modes of transport, especially when they have parking permits. However, this negative effect is much more pronounced on the use of CyRide than that of other alternate modes. The effect of time taken to go to campus is hardly significant for CyRide but a bit negatively significant for using other modes, showing a preference in driving. It is also observed that time efficiency discourages using bus and other modes, and likely to enhance driving. Factors like cost of gasoline and concern for the environment impact significantly and encourage bus and other modes use a lot more than driving. However, distance from campus does significantly reduce CyRide use, but slightly increase using other modes, if the distance is less.

Willingness to Change the Travel Mode Choice:

The dependent variable in this analysis has three outcomes, which are (i) willing to change the travel mode to go only to university (ii) willing to change the travel mode to go to university as well as other activity areas, and (iii) not willing to change at all. For convenience, we will disregard the explanatory variables which are not significant in this results in Table 10 and Table 11 (p value or level of significance is less than 0.05). Based on the results of the level of significance in these analyses, the Null Hypothesis is rejected, as some of the independent variables contribute to the willingness to change the mode of transportation to travel to university and other activity areas.

Results of Table 6 shows that for students, the factors, which significantly impact their travel behavior are, Availability of Parking Permit, Time to Return from Campus, Walking Time Taken to Reach the Nearest CyRide Stop from Residence, Satisfaction with

the CyRide Bus System, Less or No Service Availability at Night or Late Evening, Other, Gender, Count of Car of Motorcycle Ownership.

Table 6: Likelihood Ratio Tests for Willingness to Change Modal Choice for Students

	Model Fitting Criteria	Likelihood Ratio Tests	
Effect	-2 Log Likelihood of Reduced Model	Chi-Square	Sig.
Intercept	511.507[a]	.000	.
Parking Permit Availability	518.574[b]	7.067	.029
Time Taken to Go to Campus	518.960[b]	7.453	.489
Time to Leave for Campus	522.974[b]	11.467	.177
Time to Leave from Campus	529.592[b]	18.085	.021
Walking Time to Reach Nearest Transit	524.903[b]	13.396	.037
Satisfaction Level with CyRide	1284.883	773.376	.000
Barriers to Choose CyRide – Inconvenience	516.479[b]	4.972	.083
Barriers to Choose CyRide – Not Time Efficient	516.677[b]	5.170	.075
Barriers to Choose CyRide – Lack of Freedom	512.190[b]	.683	.711
Barriers to Choose CyRide – Infrequent Service, Extreme Weather, Distance of Transits from Residence	515.187[b]	3.680	.159
Barriers to Choose CyRide – Infrequent/No Service in the Late Evening/at Night	518.025[b]	6.518	.038
Barriers to Choose CyRide – Not Applicable	516.558[b]	5.051	.080
Barriers to Choose CyRide – Other	517.675[b]	6.168	.046
Residence Location	526.852[b]	15.346	.638
Age	515.748[b]	4.241	.644
Gender	521.896[b]	10.389	.034
Relationship Status	515.775[b]	4.268	.371

Race	514.008[b]	2.502	.962
Country/Continent of Residence	521.703[b]	10.196	.748
Educational Attainment	514.831[b]	3.324	.505
Possession of Car/Motorcycle	515.567[b]	4.060	.131
Number of Car/Motorcycle Owned	524.108[b]	12.601	.050
Employment Status	513.803[b]	2.296	.891
Annual Income	523.443[b]	11.936	.154

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

b. Unexpected singularities in the Hessian matrix are encountered. This indicates that either some predictor variables should be excluded or some categories should be merged.

From Table 10 (Appendix B3), we see that students will not be willing to change their travel mode choice either for trips to university or other areas, if they have parking permits. Though not significantly, but students will be willing to change their travel modes if the time of return is within 7 pm in the evening. Those who live closer to the CyRide stations will not be willing to change their mode choice. This effect is less significant when the distance gradually increases. Expectedly, those who are satisfied with the CyRide service, will be willing to use the service to go to university, changing their mode choice, if they are currently not using it. However, this willingness will not come for the trips to other activity areas. It is also revealed from the results, that students will be willing to switch to bus use if there are more frequent late night buses from the university to residence, but not from other activity areas. Both from university and other areas, male students will be more willing than the female students to change their mode choice. The

number of car or motorcycle ownership will reduce the effect of willingness to change the mode choice, with increase of the count of automobiles owned.

Results of Table 7 show that for employees, the variables that are significant in influencing the willingness to change the travel choice are Time to Return from Campus, Satisfaction with the CyRide Bus System, Inconvenience, and Lack of Freedom.

Table 7: Likelihood Ratio Tests for Willingness to Change Modal Choice for Employees

	Model Fitting Criteria	Likelihood Ratio Tests	
Effect	-2 Log Likelihood of Reduced Model	Chi-Square	Sig.
Intercept	613.116[a]	.000	.
Parking Permit Availability	618.435	5.319	.070
Time Taken to Go to Campus	620.201	7.085	.527
Time to Leave for Campus	626.246	13.131	.107
Time to Leave from Campus	630.768	17.652	.024
Walking Time to Reach Nearest Transit	616.993	3.877	.693
Satisfaction Level with CyRide	1193.544	580.428	.000
Barriers to Choose CyRide – Inconvenience	620.401	7.285	.026
Barriers to Choose CyRide – Not Time Efficient	614.059	.943	.624
Barriers to Choose CyRide – Lack of Freedom	626.009	12.893	.002
Barriers to Choose CyRide – Infrequent Service, Extreme Weather, Distance of Transits from Residence	613.920	.805	.669
Barriers to Choose CyRide – Infrequent/No Service in the Late Evening/at Night	617.076	3.960	.138

Barriers to Choose CyRide – Not Applicable	614.037	.921	.631
Barriers to Choose CyRide – Other	616.143	3.027	.220
Residence Location	627.368	14.252	.712
Age	623.734	10.618	.224
Gender	616.131	3.015	.555
Relationship Status	622.735	9.619	.142
Possession of Car/Motorcycle	613.116[a]	.000	.
Number of Car/Motorcycle Owned	617.630	4.514	.341
Annual Income	623.609	10.493	.232

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

From Table 11 (Appendix B4), we see that, if the time of return for employees is in or before early evening, there is an observed willingness to use CyRide, both to go to the university and other activity areas. Expectedly, use of CyRide to travel to university and other areas directly impacted the satisfaction level of the employees. Inconvenience will not be a major issue to change this mode choice to go to the university if the difficulties are appropriately addressed; but it will discourage to change this perception to travel to other activity areas. However, lack of freedom discourages to change the travel mode choice both to go to university and other activity areas.

CHAPTER 5: CONCLUSIONS AND LIMITATIONS

This study of travel behavior or university population of Iowa State University reveals multiple findings. It shows that driving is the most preferred modal choice for university population, especially to go to the university. Though students avail bus service to quite an extent, employees are not much willing to do the same. In fact both students and employees prefer walking and biking along with driving over any other modal choice. Currently, vanpooling or carpooling is not a very efficient modal choice for this population. Travel behavior of students and employees are vastly different and is influenced by multiple factors like demographics, culture and other personal attributes. This travel behavior is significantly different for the trips to university, but much less different for trips to other activity areas. This is because the constraints like cost of parking, or lack of parking space is not applicable while traveling to other activity areas.

Moreover, many of those destinations are quite far from the CyRide bus routes and walking from the nearest bus stops is not an ideal option, especially during winter. Results show that students are much more willing than the employees to change their travel behavior if the difficulties are addressed. This preference is also impacted by demographic factors like age, race, nationality and gender. All the regression analyses reveal that parking regulations are one of the key determinants of the travel behavior and any positive change in that would help molding the travel behavior more sustainable, having preference for public transportation.

Other factors like availability and frequency of bus service, distance of residence and other amenities from the nearest bus stops have been identified as difficulties using buses. Much less availability of early morning and late evening or night bus service

impedes students and employees to avail CyRide and somewhat compel to depend on their own cars. Those who do not avail bus service, find the same to be time-inefficient and difficult to adjust with their changing and tight schedules.

Even most of unemployed students own one or multiple cars, implying an attitudinal preference for private vehicles over alternate mode choices. However, as a whole, this analysis confirms that currently many of the residence locations and other activity areas are away from bus routes, which necessarily guides individuals to depend on private automobile. The findings of this analysis and the literature study guided the following possible policy recommendations to address the existing issues that determine the travel behavior.

Possible Policy Implications

It is important not only to have planning strategies but also to pay close attention to planning processes and implementation. Some of the planning strategies and policy recommendations, based on the literature study and the aforementioned data analysis, are as suggested below. Not all recommendations do not only aim at using the public transportation (CyRide), but also the shift of mode choice from private cars to alternate modes.

PARKING: As we see from the results, parking regulations play an extremely important role, if not the most important one, in the travel behavior. Changes on the same would be possibly the most efficient and significant policy suggestion to bring a change in the travel behavior. This would also be relatively inexpensive among most of the recommendations. Currently a mandatory fee is charged for all the students who have registered for any semester and all employees. Increasing the cost of parking relative to the

cost of public transport for students and employees will see a reduction in willingness to purchase a parking pass, along with paying for the U-Pass. In other words, the strategy is reducing the subsidization of parking, thereby more accurately reflecting the true cost of parking. There should not be any free parking in the campus for either students or employees. Decreased subsidization of parking not only decreases the attractiveness of driving, but also provides funds for TDM strategies.

A review of US universities that increased their parking fees found this approach to be one of the most effective strategies that can be employed to reduce private car use (Toor & Havlick, 2004). A coordinated effort from the city and University should be able to address the price of parking and parking policies in surrounding neighborhoods. A recommended parking management strategy, that charges the full cost of parking to all university users, was highlighted by research conducted by Tolley (1996) and Barata et al. (2011). Literature also suggests that even placing a cap on or reducing the existing number of parking spaces will be a way to prevent using private cars. Approaches may include restrictions on the provision of off-street parking in new suburban developments. Also, for the employees, the charges for parking permits are auto-debited from their compensations, but employees need to buy the CyRide pass separately with cash. If the U-Pass can be bought as easily as buying parking permits, it would be hassle free and make the employees choose this option more. Economic incentives also can be used to discourage driving. For instance, Stanford pays 2500 employees who do not purchase a parking permit during the year through its ‘Clean Air Cash’ program.

Reduce the Travel Time Barrier: A large share of responses from the students’ population conveyed more frequent service would encourage them to use public

transportation. For this, our next intended recommendation would be to increase the public transport services, in terms of number of buses and frequency. Though this requires further feasibility analysis and in depth research, and will involve more planning effort, in terms of the positive impact it can bring in, this suggestion will be of great importance.

The most significant barrier to active commuting for staff and students, regardless of how close they live to the University or how they travel, is travel time. This is consistent with the 'law of constant travel time' which demonstrates that average daily travel times within urban populations remain constant because commuters seek to minimize their travel time and will change modes in order to do so (Hupkes, 1982; Schafer & Victor, 2000; Zahavi & Talvitie, 1980). Given that the barrier item 'public transport between my home and UWA is too infrequent' was rated as reasonably important by staff and students, increased public transport services would assist in reducing barriers to active commuting.

Based on the above network analysis (Figure 36, and Figure 37), extension of existing routes are proposed (Figure 38 and Figure 39); where students and employees could avail the service much more easily. From these maps, it is revealed that the routes are most required to be extended on Brown (6) route at the very north and south of Ames. The facts from CyRide tell us that the neighborhoods around the university are undersupplied relative to the demand, suggesting that such an approach has promise. Though, the budget is limited to provide additional buses, a small but gradual increase in the U-Pass fees could help in raising funds. Also, a very small portion of residents, who are not associated with the university, use CyRide service. Many of the residential areas do not have bus routes in their proximity. If residents of the neighborhoods, irrespective of having any association

with the university, start using the bus services and pay for their rides, budget constraints can be addressed – making CyRide services more viable to conduct.

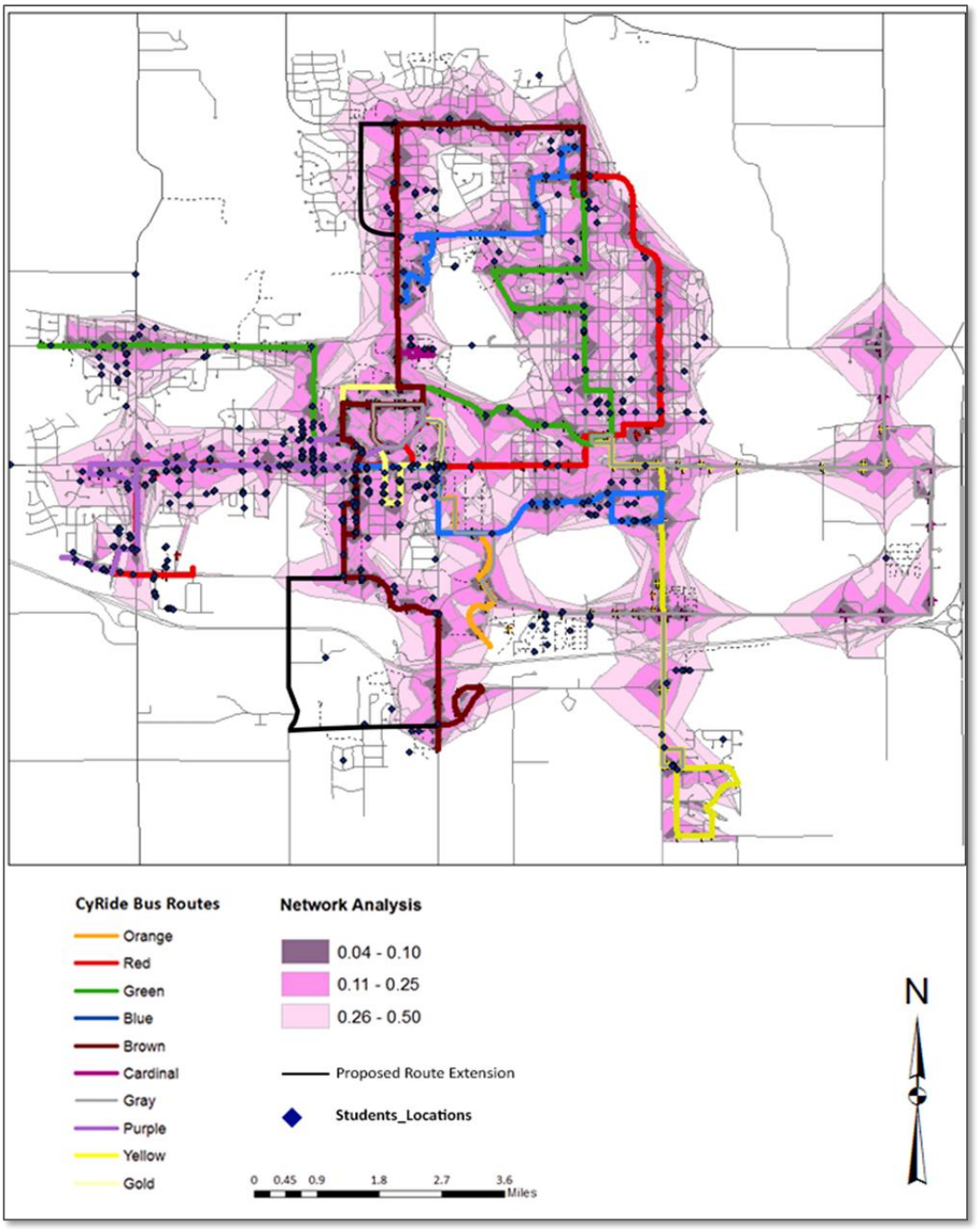


Figure 38: Proposed Route Extension Based On Network Analysis With Students' Residences

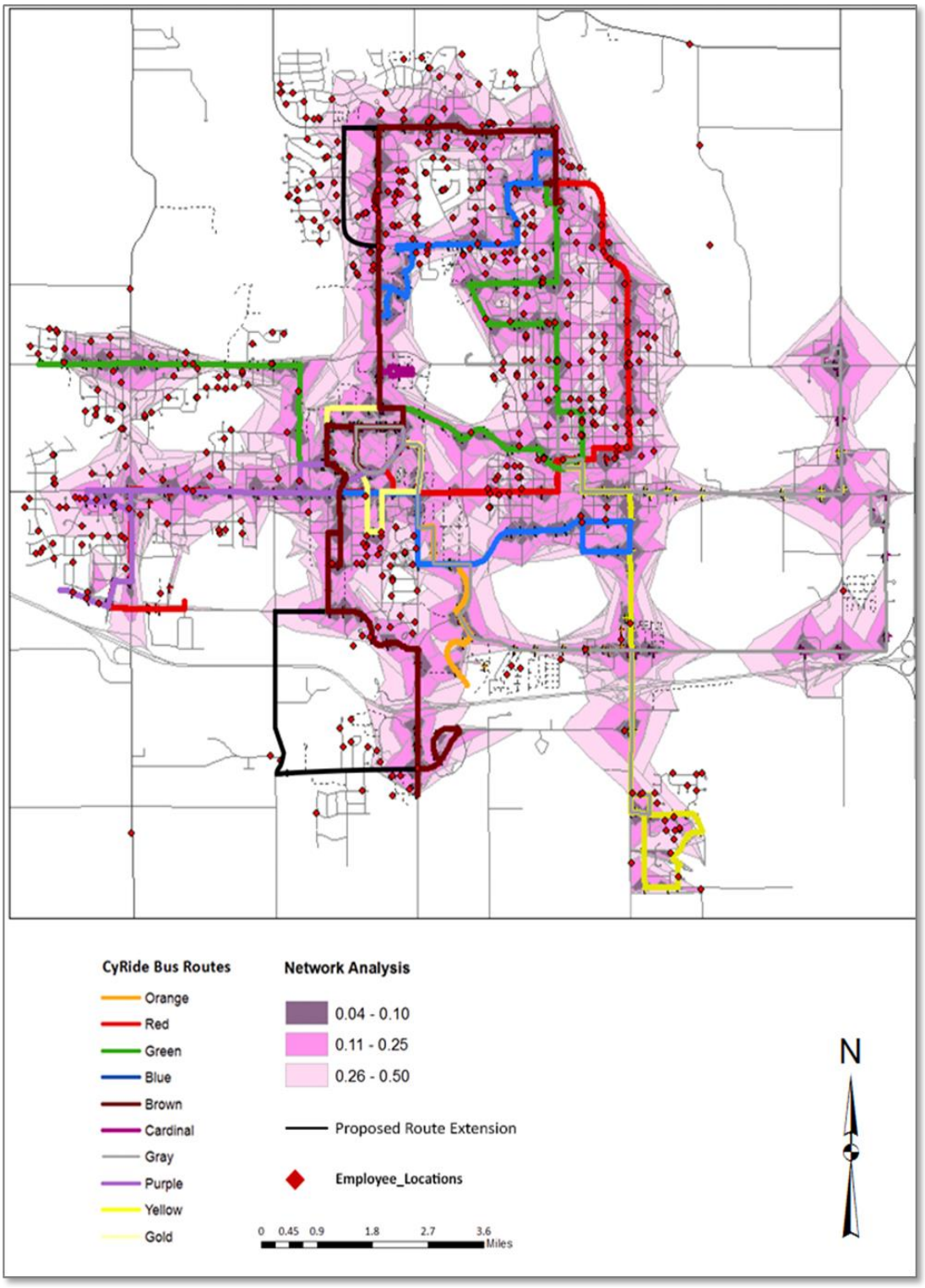


Figure 39: Proposed Route Extension Based On Network Analysis With Employees' Residences

Land Use strategies and Mixed-Use Development: A significant number of university population is observed to be living away from the campus, though all of them do not own the residences they live in. It is important to increase the number of staff and students living within walking distance of the campus. Those who live with roommates were found to be more likely to avail of carpooling or bus than those who live alone or with families. This study shows that living with friends or classmates nearby the campus increase the odds of using alternative modes in general or taking public transit in particular. Thus, this indicates that promotion of alternative modes should care about various means to encourage students to live with or near other students. The key role player for this will be local government body and city planning commissions. The evidence, that individuals are willing to use public transport to other activity areas, supports the development of more compact city type of neighborhoods, which are self-supporting in terms of facilities, and meeting the housing market that fits residents with less car dependent orientation. This is consistent with the recommendations of other studies: shaping more balanced, smarter infrastructure growth, mixed-use patterns in urban development towards meeting the low carbon future (Falk, 2009; Scheiner, 2010). Lower car ownership and less car use are associated with living in high-density and mixed-use neighborhoods, which have poor car accessibility and proximity to public transits. However, these infrastructural changes will not time consuming and expensive, it will not be as easy to implement as above recommendations. .

The study showed the safety and shopping accessibility factors have a strong contribution to car ownership. An inference is that a good shopping accessibility from the bus routes tends to create an environment less conducive to driving. This finding provides

evidence for the recommendations of the Barker review (2006): it is important to develop accessible supermarkets/shops to meet local residential market and large supermarket chains should expand in terms of sites rather than concentration on few large stores.

Organizational Aspects: It is important to have students in the transportation advisory committees since many times students are the ones asking campus administrators to make the settings of their education more sustainable. Also local user groups have a very important role in monitoring and revising campus sustainable transportation policies. UC Boulder, home of one of the nation's largest student run environmental resource center, has no formal bicycle committee, but the UC Environmental Center lobbies for alternative transportation very often. Students Community Service Organization can be created to communicate directly with the police departments and convey students' concerns and issues to them. UC Santa Barbara has a special community service organization (CSO) that was created as an organization of students to serve as liaison between the students and the police department. CSOs patrol the campus year-round, reporting crimes in progress, assisting in emergency situations, detecting safety hazards, and warning or enforcing bicycle regulations.

Education and Enforcement: Inclusion of courses on alternate modes of transportation in the curriculum to educate and raise awareness among the university population would be another recommendation. For example, Cornell University has created the Internet based e-learning course, 'Getting around Cornell'. An overall behavioral and attitudinal change would help changing the travel behavior immensely and education would help that to achieve effectively.

Limitations and Future Scope Of Research

Though, with a high response rate and thorough statistical analyses, the study is expected to have some concrete meaningful results in terms of planning strategies; several limitations, as follows, restrict the extent of depth of analyses and thus leaves scope for future research.

1. When analyzing the representativeness of the samples from the populations, most of the information of the populations on the independent variables was not available. A very few variables of the populations could be compared with that of the samples, and thus a confirmed decision on the biasedness could not be made. Only a likelihood of this bias could be assumed and stated in the analysis.
2. The survey questionnaires were made as succinct as possible. This stops from having some very useful information related to the study.
3. A major proportion of the employees reside outside Ames. Thus a strong bias toward private car preference in the responses was inevitable.
4. This study deals with the cross-sectional data. But a longitudinal data to determine a change or shift from private cars to public transport or non-motorized mode would have been more focused and appropriate, instead.
5. The list of email addresses includes a small percentage of distance students. Also, a few drop outs from the survey narrowed down the response rate for the students.
6. A study on bike share initiatives is already been looked into at ISU. Thus I my focus from the same.

7. Though, it is one of the major alternative transport option, vanpooling or carpooling are not much in use at ISU. So the survey questions and my analyses hardly cover this mode.
8. The study did not have a scope to compare the travel pattern of faculty with that of staff of the university. The entire employee population has been treated as a single set.
9. None of the populations include the residents who are not associated with the university, because the primary data could not be collected. Hence, this study necessarily deals with only the university population. But as CyRide is a city service available to everyone, not only for student, it would have been more thoughtful if all the residents of Ames could be taken into account.

This study identified the need for future research on travel pattern based on perceptions and behavioral effects. The data responses include information on biking and walking, which is not taken into account in this study. So a research should include a detailed analysis of travel beavior with biking and walking of university population and make recommendations including bicycle-lending programs accordingly. Moreover, CyRide being a city service, study on all the residents including the ones that are not associated to the university, should be considered. An extensive GIS and data analysis with CyRide statistics will also be extremely helpful to study the feasibility of new routes or extension of routes, if proposed. Also, faculty and staff population are vastly different in characteristics. But this study combines the two populations. It would be insightful to have comparative analysis on individual populations.

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APPENDIX A: IRB APPROVAL FORM

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
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Date: 12/18/2014

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From: Office for Responsible Research

Title: Travel Behavior and Perceptions Towards Public Transportation in Iowa State University

IRB ID: 14-637

Study Review Date: 12/18/2014

The project referenced above has been declared exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b) because it meets the following federal requirements for exemption:

- (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey or interview procedures with adults or observation of public behavior where
  - Information obtained is recorded in such a manner that human subjects cannot be identified directly or through identifiers linked to the subjects; or
  - Any disclosure of the human subjects' responses outside the research could not reasonably place the subject at risk of criminal or civil liability or be damaging to their financial standing, employability, or reputation.

The determination of exemption means that:

- **You do not need to submit an application for annual continuing review.**

- **You must carry out the research as described in the IRB application.** Review by IRB staff is required prior to implementing modifications that may change the exempt status of the research. In general, review is required for any modifications to the research procedures (e.g., method of data collection, nature or scope of information to be collected, changes in confidentiality measures, etc.), modifications that result in the inclusion of participants from vulnerable populations, and/or any change that may increase the risk or discomfort to participants. Changes to key personnel must also be approved. The purpose of review is to determine if the project still meets the federal criteria for exemption.

  Non-exempt research is subject to many regulatory requirements that must be addressed prior to implementation of the study. Conducting non-exempt research without IRB review and approval may constitute non-compliance with federal regulations and/or academic misconduct according to ISU policy.

  Detailed information about requirements for submission of modifications can be found on the Exempt Study Modification Form. A Personnel Change Form may be submitted when the only modification involves changes in study staff. If it is determined that exemption is no longer warranted, then an Application for Approval of Research Involving Humans Form will need to be submitted and approved before proceeding with data collection.

Please note that you must submit all research involving human participants for review. Only the IRB or designees may make the determination of exemption, even if you conduct a study in the future that is exactly like this study.

Please be aware that **approval from other entities may also be needed.** For example, access to data from private records (e.g. student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. **An IRB determination of exemption in no way implies or guarantees that permission from these other entities will be granted.**

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.

APPENDIX B1: PARAMETER ESTIMATES 1

Table 8: Factors Influencing Travel Behavior in Student Population

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
CyRide	Intercept	-6.599	0.999			
	[Parking Permit Availability = No]	1.058	0.017	2.881	1.21	6.859
	[Parking Permit Availability= Yes]	0[b]	.	.	.	.
	[Time Taken to Go to Campus =3]	4.44	0.303	84.74	0.018	396846.17
	[Time Taken to Go to Campus =8]	5.795	0.178	328.501	0.072	1496612
	[Time Taken to Go to Campus =15]	6.686	0.12	801.141	0.174	3686714.3
	[Time Taken to Go to Campus =25]	9.858	0.023	19116.614	3.805	96050457
	[Time Taken to Go to Campus =40]	0[b]	.	.	.	.
	[Walking Time to Reach Nearest Transit =3]	5.541	0.001	254.926	8.403	7733.889
	[Walking Time to Reach Nearest Transit =8]	3.075	0.075	21.648	0.734	638.314
	[Walking Time to Reach Nearest Transit =20]	5.039	0.009	154.339	3.512	6782.293
	[Walking Time to Reach Nearest Transit =45]	0[b]	.	.	.	.
	[Primary Reasons for Mode Choice - Affordability= No]	-2.401	0	0.091	0.038	0.215
	[Primary Reasons for Mode Choice - Affordability= Yes]	0[b]	.	.	.	.
	[Primary Reasons for Mode Choice – Freedom= No]	3.412	0	30.311	12.783	71.876
	[Primary Reasons for Mode Choice – Freedom= Yes]	0[b]	.	.	.	.
	[Primary Reasons for Mode Choice – Weather, Safety, Lack of Parking Space, Lack of Lighting= No]	-1.107	0.005	0.331	0.152	0.718

Table 8 (Continued)

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
CyRide	Intercept	-6.599	0.999			
	[Primary Reasons for Mode Choice – Weather, Safety, Lack of Parking Space, Lack of Lighting = Yes]	0[b]	.	.	.	.
	[Primary Reasons for Mode Choice – Cost of Gas, Concern for Environment= No]	-1.33	0.011	0.264	0.094	0.74
	[Primary Reasons for Mode Choice – Cost of Gas, Concern for Environment= Yes]	0[b]	.	.	.	.
	[Primary Reasons for Residence Choice – Distance from Campus= No]	-0.393	0.378	0.675	0.282	1.617
	[Primary Reasons for Mode Choice – Weather, Safety, Lack of Parking Space, Lack of Lighting= No]	-1.107	0.005	0.331	0.152	0.718
	[Primary Reasons for Residence Choice – Distance from Campus= Yes]	0[b]	.	.	.	.
	[Primary Reasons for Residence Choice – Mode of Transport Available, Safety= No]	-0.174	0.646	0.84	0.399	1.767
	[Primary Reasons for Residence Choice – Mode of Transport Available, Safety= Yes]	0[b]	.	.	.	.
	[Primary Reasons to Choose CyRide– Convenience= No]	-1.559	0.006	0.21	0.069	0.644
	[Primary Reasons to Choose CyRide– Convenience= Yes]	0[b]	.	.	.	.
	[Primary Reasons to Choose CyRide– Extreme Weather Conditions= No]	-0.078	0.869	0.925	0.367	2.334

Table 8 (Continued)

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
CyRide	Intercept	-6.599	0.999			
	[Primary Reasons to Choose CyRide– Extreme Weather Conditions= Yes]	0[b]	.	.	.	.
	[Age =20]	0.73	0.461	2.075	0.298	14.469
	[Age =23]	1.607	0.082	4.989	0.817	30.47
	[Age =27]	1.983	0.056	7.264	0.953	55.389
	[Age =32]	0[b]	.	.	.	.
	[Race=White]	-2.991	0.066	0.05	0.002	1.217
	[Race=African American]	-4.843	0.01	0.008	0	0.32
	[Race=American Indian and Alaska Native]	24.737	0.986	5.533E+10	0	.c
	[Race=Asian]	-3.134	0.067	0.044	0.002	1.24
	[Race =Other]	0b	.	.	.	.
	[Possession of Car/Motorcycle= No]	15.682	0.991	6468076.8	0	.c
	[Possession of Car/Motorcycle = Yes]	0b	.	.	.	.
	[Number of Car/Motorcycle Owned =0]	-15.142	0.992	2.65E-07	0	.c
	[Number of Car/Motorcycle Owned =1]	-0.319	0.856	0.727	0.023	22.941
Other Modes	Intercept	-9.325	0.995			
	[Parking Permit Availability= No]	0.716	0.04	2.047	1.034	4.053
	[Parking Permit Availability= Yes]	0b	.	.	.	.
	[Time Taken to Go to Campus =3]	3.36	0.384	28.778	0.015	55483.405
	[Time Taken to Go to Campus =8]	3.113	0.419	22.499	0.012	42678.763
	[Time Taken to Go to Campus =15]	3.799	0.325	44.655	0.023	86063.513
	[Time Taken to Go to Campus =25]	4.563	0.239	95.852	0.048	190353.49
	[Time Taken to Go to Campus =40]	0b	.	.	.	.
	[Walking Time to Reach Nearest Transit =3]	1.581	0.054	4.858	0.973	24.266
	[Walking Time to Reach Nearest Transit =8]	-0.716	0.402	0.489	0.091	2.611

Table 8 (Continued)

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
Other Modes	Intercept	-9.325	0.995			
	[Walking Time to Reach Nearest Transit =20]	-0.362	0.768	0.696	0.063	7.709
	[Walking Time to Reach Nearest Transit =45]	0b	.	.	.	.
	[Primary Reasons for Mode Choice - Affordability= No]	-1.713	0	0.18	0.086	0.378
	[Primary Reasons for Mode Choice - Affordability= Yes]	0b	.	.	.	.
	[Primary Reasons for Mode Choice – Freedom= No]	0.695	0.033	2.005	1.058	3.797
	[Primary Reasons for Mode Choice – Freedom= Yes]	0b	.	.	.	.
	[Primary Reasons for Mode Choice – Weather, Safety, Lack of Parking Space, Lack of Lighting= No]	0.393	0.234	1.482	0.776	2.831
	[Primary Reasons for Mode Choice – Weather, Safety, Lack of Parking Space, Lack of Lighting= Yes]	0b	.	.	.	.
	[Primary Reasons for Mode Choice – Cost of Gas, Concern for Environment= No]	-1.299	0.005	0.273	0.11	0.677
	[Primary Reasons for Mode Choice – Cost of Gas, Concern for Environment= Yes]	0b	.	.	.	.
	[Primary Reasons for Residence Choice – Distance from Campus= No]	-1.723	0	0.178	0.086	0.371
	[Primary Reasons for Residence Choice – Distance from Campus = Yes]	0b	.	.	.	.
	[Primary Reasons for Residence Choice – Mode of Transport Available, Safety= No]	0.497	0.115	1.644	0.886	3.051

Table 8 (Continued)

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
Other Modes	Intercept	-9.325	0.995			
	[Primary Reasons for Residence Choice – Mode of Transport Available, Safety= Yes]	0b	.	.	.	.
	[Primary Reasons to Choose CyRide– Convenience= No]	0.007	0.989	1.007	0.366	2.77
	[Primary Reasons to Choose CyRide– Convenience= Yes]	0b	.	.	.	.
	[Primary Reasons to Choose CyRide– Extreme Weather Conditions= No]	-1.17	0.007	0.31	0.132	0.731
	[Primary Reasons to Choose CyRide– Extreme Weather Conditions= Yes]	0b	.	.	.	.
	[Age =20]	1.617	0.099	5.036	0.739	34.314
	[Age =23]	1.547	0.09	4.695	0.785	28.08
	[Age =27]	1.378	0.144	3.967	0.624	25.237
	[Age =32]	0b	.	.	.	.
	[Race=White]	-1.783	0.302	0.168	0.006	4.952
	[Race=African American]	-3.031	0.108	0.048	0.001	1.946
	[Race=American Indian and Alaska Native]	24.467	0.986	4.224E+10	0	.c
	[Race=Asian]	-1.627	0.358	0.196	0.006	6.313
	[Number of Car/Motorcycle Owned =2]	3.223	0.074	25.115	0.73	863.8
	[Number of Car/Motorcycle Owned =3or more]	0b	.	.	.	.

APPENDIX B2: PARAMETER ESTIMATES 2

Table 9: Factors Influencing Travel Behavior in Employee Population

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
CyRide	Intercept	-214.109	0.974			
	[Parking Permit Availability= No]	55.8	0.969	1.712E+24	0	.b
	[Parking Permit Availability= Yes]	0c	.	.	.	.
	[Time Taken to Go to Campus =3]	-72.599	0.973	2.96E-32	0	.b
	[Time Taken to Go to Campus =8]	61.224	0.957	3.885E+26	0	.b
	[Time Taken to Go to Campus =15]	94.086	0.95	7.26E+40	0	.b
	[Time Taken to Go to Campus =25]	105.162	0.938	4.69E+45	0	.b
	[Time Taken to Go to Campus =40]	0c	.	.	.	.
	[Primary Reasons for Mode Choice – Time Efficiency= No]	11.641	0.986	113693.53	0	.b
	[Primary Reasons for Mode Choice – Time Efficiency= Yes]	0c	.	.	.	.
	[Primary Reasons for Mode Choice – Cost of Gas, Concern for Environment= No]	-44.321	0.942	5.64E-20	0	.b
	[Primary Reasons for Mode Choice – Cost of Gas, Concern for Environment= Yes]	0c	.	.	.	.
	[Primary Reasons for Residence Choice – Distance from Campus= No]	56.418	0.921	3.176E+24	0	.b
	[Primary Reasons for Residence Choice – Distance from Campus= Yes]	0c	.	.	.	.

Table 9 (Continued)

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
Other modes	Intercept	3.69	0.218			
	[Parking Permit Availability= No]	1.415	0.001	4.116	1.851	9.151
	[Parking Permit Availability= Yes]	0[c]	.	.	.	.
	[Time Taken to Go to Campus =3]	-3.372	0.003	0.034	0.004	0.317
	[Time Taken to Go to Campus =8]	-2.396	0.004	0.091	0.018	0.466
	[Time Taken to Go to Campus =15]	-0.972	0.228	0.378	0.078	1.839
	[Time Taken to Go to Campus =25]	-0.769	0.235	0.463	0.13	1.648
	[Time Taken to Go to Campus =40]	0[c]	.	.	.	.
	[Primary Reasons for Mode Choice – Time Efficiency= No]	1.076	0.008	2.932	1.318	6.524
	[Primary Reasons for Mode Choice – Time Efficiency= Yes]	0[c]	.	.	.	.
	[Primary Reasons for Mode Choice – Cost of Gas, Concern for Environment= No]	-4.171	0	0.015	0.005	0.043
	[Primary Reasons for Mode Choice – Cost of Gas, Concern for Environment= Yes]	0[c]	.	.	.	.
	[Primary Reasons for Residence Choice – Distance from Campus= No]	-0.936	0.017	0.392	0.182	0.847
	[Primary Reasons for Residence Choice – Distance from Campus = Yes]	0[c]	.	.	.	.

APPENDIX B3: PARAMETER ESTIMATES 3

Table 10: Willingness to Change Travel Behavior in Student Population

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
Yes – to University	Intercept	9.324	0.993			
	[Parking Permit Availability= No]	-2.467	0.049	0.085	0.007	0.984
	[Parking Permit Availability= Yes]	0[b]	.	.	.	.
	[Time to Leave from Campus=Before 4 pm]	-2.45	0.317	0.086	0.001	10.456
	[Time to Leave from Campus=4-5.30 pm]	3.171	0.215	23.833	0.159	3572.54
	[Time to Leave from Campus=5.30-7 pm]	0.66	0.77	1.936	0.023	161.945
	[Time to Leave from Campus=7-8.30 pm]	-8.125	0.433	0	4.48E-13	195744.93
	[Time to Leave from Campus= After 8.30 pm]	0[b]	.	.	.	.
	[Walking Time to Reach Nearest Transit =3]	-9.217	0.013	9.93E-05	7.01E-08	0.141
	[Walking Time to Reach Nearest Transit =8]	-7.844	0.023	0	4.52E-07	0.34
	[Walking Time to Reach Nearest Transit =20]	-6.805	0.133	0.001	1.55E-07	7.938
	[Walking Time to Reach Nearest Transit =45]	0[b]	.	.	.	.
	[Satisfaction Level with CyRide=Not Applicable]	-41.865	0.932	6.58E-19	0	.[c]
	[Satisfaction Level with CyRidee =Very Dissatisfied]	-9.101	0.997	0	0	.[c]
	[Satisfaction Level with CyRidee=Dissatisfied]	14.252	0.997	1546524.2	0	.[c]
	[Satisfaction Level with CyRide=Somewhat Dissatisfied]	-1.293	0.999	0.274	0	.[c]
	[Satisfaction Level with CyRide=Neutral]	4.06	0.997	57.949	0	.[c]
	[Satisfaction Level with CyRide=Somewhat Satisfied]	-22.029	0.964	2.71E-10	0	.[c]
	[Satisfaction Level with CyRide=Satisfied]	1.297	0.998	3.659	0	.[c]
	[Satisfaction Level with CyRide=Very Satisfied]	0[b]	.	.	.	.
	[Barriers to Choose CyRide – Infrequent/No Service in the Late Evening/at Night= No]	-0.453	0.745	0.636	0.042	9.729

Table 10 (Continued)

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
Yes – to University	Intercept	9.324	0.993			
	[Barriers to Choose CyRide – Infrequent/No Service in the Late Evening/at Night= Yes]	0[b]	.	.	.	.
	[Barriers to Choose CyRide – Other = No]	3.226	0.064	25.175	0.828	765.376
	[Barriers to Choose CyRide – Other= Yes]	0[b]	.	.	.	.
	[Gender =Male]	16.228	0	11163364	308627.03	403790642
	[Gender=Female]	13.909	0	1098199.4	114790.03	10506504
	[Gender=Do not wish to state]	0[b]	.	.	.	.
	[Number of Car/Motorcycle Owned =0]	18.235	0.395	83035755	4.81E-11	1.434E+26
	[Number of Car/Motorcycle Owned =1]	7.043	0.083	1144.27	0.403	3245797.9
	[Number of Car/Motorcycle Owned =2]	5.549	0.135	256.886	0.178	370702.17
	[Number of Car/Motorcycle Owned=3 or more]	0[b]	.	.	.	.
Yes – to University and Other Places	Intercept	-27.522	0.997			
	[Parking Permit Availability= No]	-1.774	0.153	0.17	0.015	1.934
	[Parking Permit Availability= Yes]	0b	.	.	.	.
	[Time to Leave from Campus= Before 4 pm]	-2.988	0.218	0.05	0	5.825
	[Time to Leave from Campus=4-5.30 pm]	2.355	0.353	10.534	0.074	1507.629
	[Time to Leave from Campus=5.30-7 pm]	0.287	0.898	1.333	0.017	106.166
	[Time to Leave from Campus=7-8.30 pm]	-8.093	0.435	0	4.65E-13	200660.34
	[Time to Leave from Campus=After 8.30 pm]	0b	.	.	.	.
	[Walking Time to Reach Nearest Transit =3]	-8.574	0.02	0	1.42E-07	0.252
	[Walking Time to Reach Nearest Transit =8]	-7.518	0.027	0.001	6.90E-07	0.428
	[Walking Time to Reach Nearest Transit =20]	-7.649	0.095	0	5.95E-08	3.817
	[Walking Time to Reach Nearest Transit =45]	0b	.	.	.	.
	[Satisfaction Level with CyRide= Not Applicable]	-39.164	0.937	9.80E-18	0	.c
	[Satisfaction Level with CyRide=Very Dissatisfied]	-8.532	0.997	0	0	.c

Table 10 (Continued)

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
Yes – to University and Other Places	Intercept	-27.522	0.997			
	[Parking Permit Availability= No]	-1.774	0.153	0.17	0.015	1.934
	[Satisfaction Level with CyRide=Dissatisfied]	-1.801	1	0.165	0	.c
	[Satisfaction Level with CyRide=Somewhat Dissatisfied]	-0.948	0.999	0.387	0	.c
	[Satisfaction Level with CyRide=Neutral]	3.791	0.997	44.321	0	.c
	[Satisfaction Level with CyRide=Somewhat Satisfied]	-22.206	0.964	2.27E-10	0	.c
	[Satisfaction Level with CyRide=Satisfied]	1.004	0.999	2.73	0	.c
	[Satisfaction Level with CyRide=Very Satisfied]	0b	.	.	.	.
	[Barriers to Choose CyRide – Infrequent/No Service in the Late Evening/at Night= No]	0.343	0.804	1.409	0.094	21.053
	[Barriers to Choose CyRide – Infrequent/No Service in the Late Evening/at Night= Yes]	0b	.	.	.	.
	[Barriers to Choose CyRide – Other= No]	2.609	0.133	13.59	0.452	408.637
	[Barriers to Choose CyRide – Other=Yes]	0b	.	.	.	.
	[Gender= Male]	17.13	0	27507000	1699310.6	445260021
	[Gender=Female]	14.273	.	1579397.4	1579397.4	1579397.4
	[Number of Car/Motorcycle Owned =0]	34.567	0.991	1.029E+15	0	.c
	[Number of Car/Motorcycle Owned =1]	24.001	0.994	2.652E+10	0	.c
	[Number of Car/Motorcycle Owned =2]	22.752	0.994	7.606E+09	0	.c
	[Number of Car/Motorcycle Owned =3 or more]	0b	.	.	.	.

APPENDIX B4: PARAMETER ESTIMATES 4

Table 11: Willingness to Change Travel Behavior in Employee Population

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
Yes – to University	Intercept	-28.302	0.996			
	[Time to Leave from Campus= Before 4 pm]	11.761	0.986	128094.25	0	.c
	[Time to Leave from Campus=4-5.30 pm]	13.686	0.983	878643.92	0	.[c]
	[Time to Leave from Campus=5.30-7 pm]	13.681	0.983	873996	0	.[c]
	[Time to Leave from Campus=7-8.30 pm]	13.193	0.984	536600.89	0	.[c]
	[Time to Leave from Campus = After 8.30 pm]	0[b]	.	.	.	.
	[Satisfaction Level with CyRide=Not Applicable]	-7.804	0	0	4.30E-05	0.004
	[Satisfaction Level with CyRide=Very Dissatisfied]	12.518	0.996	273178.93	0	.[c]
	[Satisfaction Level with CyRide=Dissatisfied]	13.963	0.998	1158470.6	0	.[c]
	[Satisfaction Level with CyRide=Somewhat Dissatisfied]	21.496	0.988	2.165E+09	0	.[c]
	[Satisfaction Level with CyRide=Neutral]	23.11	0.98	1.087E+10	0	.[c]
	[Satisfaction Level with CyRide =Somewhat Satisfied]	12.741	0.991	341528.78	0	.[c]
	[Satisfaction Level with CyRide=Satisfied]	-0.267	0.839	0.766	0.058	10.061
	[Satisfaction Level with CyRide=Very Satisfied]	0[b]	.	.	.	.
	[Barriers to Choose CyRide – Inconvenience 0]	0.567	0.091	1.762	0.914	3.399
	[Barriers to Choose CyRide – Inconvenience = Yes]	0[b]	.	.	.	.
	[Barriers to Choose CyRide – Lack of Freedom= No]	1.289	0.001	3.628	1.708	7.705
	[Barriers to Choose CyRide – Lack of Freedom= Yes]	0[b]	.	.	.	.

Table 11 (Continued)

		B	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
					Lower Bound	Upper Bound
Yes – to University and Other Places	Intercept	-22.629	0.989			
	[Time to Leave from Campus= Before 4 pm]	25.566	0.988	1.269E+11	0	.[c]
	[Time to Leave from Campus=4-5.30 pm]	27.931	0.987	1.35E+12	0	.[c]
	[Time to Leave from Campus=5.30-7 pm]	28.502	0.986	2.388E+12	0	.[c]
	[Time to Leave from Campus=7-8.30 pm]	11.383	0.996	87823.023	0	.[c]
	[Time to Leave from Campus= After 8.30 pm]	0[b]	.	.	.	.
	[Satisfaction Level with CyRide=Not Applicable]	-7.536	0	0.001	4.38E-05	0.007
	[Satisfaction Level with CyRide=Very Dissatisfied]	-5.567	.	0.004	0.004	0.004
	[Satisfaction Level with CyRide=Dissatisfied]	14.372	0.997	1744366	0	.[c]
	[Satisfaction Level with CyRide=Somewhat Dissatisfied]	21.105	0.988	1.464E+09	0	.[c]
	[Satisfaction Level with CyRide=Neutral]	23.435	0.98	1.506E+10	0	.[c]
	[Satisfaction Level with CyRide=Somewhat Satisfied]	11.835	0.991	138031.31	0	.[c]
	[Satisfaction Level with CyRide=Satisfied]	-0.001	1	0.999	0.065	15.441
	[Satisfaction Level with CyRidee=Very Satisfied]	0[b]	.	.	.	.
	[Barriers to Choose CyRide – Inconvenience = No]	-0.581	0.272	0.559	0.199	1.576
	[Barriers to Choose CyRide – Inconvenience = Yes]	0b	.	.	.	.
	[Barriers to Choose CyRide – Lack of Freedom= No]	1.272	0.023	3.567	1.187	10.72
	[Barriers to Choose CyRide – Lack of Freedom= Yes]	0b	.	.	.	.